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SVIC NOTES

The Nuts and Bolts of the Situation

Bolts and nuts are used as fasteners in many types of equipment, and to ensure the integrity of the bolted joint the equipment designer must design the bolted joint properly. This includes knowing the loads that will act on the joint and its potential failure modes. Just considering vibration alone, bolted joints may fail by fretting corrosion between the slipping joint members, fatigue of the bolts, fatigue of the bolted members, and by loosening of the bolted connections.

Once the bolt loosens during vibration, it is free to rotate and back out of its mating thread. I will concentrate on the bolt loosening failure mode because I think it is the most prevalent. This is especially true of mechanical type failures of electronic equipment; a large percentage of these failures can be traced to the fasteners, and many of these failures have been caused by the loosening of bolts (1).

Because bolted joints are so commonly used in many items of equipment, some designers tend to take them for granted; in the presence of more pressing design requirements some designers may overlook the need to design the bolted joint, or if the equipment will be exposed to vibration, they may overlook the effects of vibration on bolted joints. The proper design of bolted joints is complex because of the many variables to consider.

The literature on the dynamic behavior of all types of joints published during the last ten years is extensive, and a great deal of it pertains to the vibration of bolted joints. Several papers or reports provide useful information on the vibrations of bolts and the techniques for designing vibration-resistant bolted joints (2) (3) (4) (5). Reference 3 also contains an extensive list of references on this subject. According to all of the authors of the above papers the best way to obtain a vibration resistant bolted joint is to preload it. This will prevent the bolt from moving regardless of how the vibration is applied to the joint, either axially, transversely, or in flexure. In addition many types of thread locking devices are available, but most of these same authors question the effectiveness of many of the thread locking devices in preventing bolts from moving when vibration is applied to the joint.

Nuts and bolts alone may appear to be simple, but when they are used as fasteners in equipment they become complex systems. Their proper selection depends on the design of the bolted joint; fortunately ample design guidelines are available.

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EDITORS RATTLE SPACE

THE ROLE OF SECONDARY JOURNALS IN OBTAINING ENGINEERING INFORMATION

Since the initial publication of the SHOCK AND VIBRATION DIGEST in 1969, the number of technical journals publishing articles on shock and vibration has almost doubled. Every year we see several new technical journals appear. Twenty five years ago the principal portion of the literature was concentrated in about ten journals. Today, the significant concentration of the literature is in fifty journals. This means that it is more difficult, if not impossible, for the engineer to keep up with the literature.

Active use of published technical material does increase the efficiency of our engineering work force. It saves the time of "reinventing the wheel" and provides new ideas directly or initiates new ideas. The use of published technical material can and does save millions of dollars in labor and hardware each year. It not only provides new ideas and techniques, but also keeps us from trying methods that do not work.

Because the shock and vibration literature is published in over one-hundred journals, direct access is both time consuming and inefficient. Secondary journals like the DIGEST, where the literature is focused and organized must be used to obtain an overview of what is published. The DIGEST brings shock and vibration information together in organized topical form so the engineer can efficiently scan the literature for a month in less than an hour. In the DIGEST, information on the published literature is categorized by broad and narrow topics. The abstracts of the articles published in a given area can be examined in a matter of minutes. Then articles of genuine interest can be obtained. This process can provide a steady flow of new and useful information for an engineer. The annual index of key words published in the DIGEST provides the means to obtain information published in specific topic areas since 1968.

The DIGEST can increase the efficiency and productivity of engineers in the Shock and Vibration area. Any suggestions by the readers of the DIGEST to increase its usefulness will be greatly appreciated.

R.L.E.

THE COMPUTER AGE AND THE USEFULNESS OF OLD IDEAS

P.A.A. Laura*

Abstract. This paper presents a brief discussion of optimization approaches that improve the efficiency of the finite element method. The recently developed k-optimization parameter method for determining natural frequencies and buckling loads is emphasized.

The computer has been a technological achievement that now affects practically every aspect of man's daily life. The digital computer has made possible the solution of problems for which numerical evaluations were once virtually impossible.

But it has been said that caution is necessary when a standard procedure -- regardless of the size of the problem -- involves a computer solution [1]. The popularity of computer solutions has resulted in a loss of insight into the physical aspects of problems. Free computer time has also led to a loss of analytical skills for engineering and applied science students who depend on readily available computer programs prepared by others [2].

The older analytical methods, such as Rayleigh-Ritz, Ritz, and Galerkin, can be used to solve many important technical and scientific problems; indeed, these methods are the foundation upon which are based many of the numerical techniques now used on the computer.

It is the purpose of this paper to show that a concept of Lord Rayleigh -- a concept not used practically for almost a century -- offers possibilities for adapting the finite element method to problems and elastic stability.

HISTORICAL BACKGROUND

Consider the problem of a vibrating circular membrane of radius a in the case of axisymmetric modes of vibration. The fundamental frequency coefficient, which is available in standard textbooks, is given by

$$\Omega_{oo} = \sqrt{\rho/T}\,\omega_{oo}\,a = \alpha_{oo}$$

where

α_{00} = first root of Bessel's function of the first kind and zero order (α_{00} = 2.4048)

ρ = area density of the membrane

T = applied, radial tension (per unit length)

ω_{00} = fundamental circular frequency

It is common to demonstrate the value of the Rayleigh-Ritz or Galerkin methods by using them to determine the fundamental frequency coefficient.

An approximate expression for the fundamental mode shape is used.

(1) $$W(r) \simeq W_a(r) = A(a^2 - r^2)$$

Application of the Rayleigh-Ritz method leads to a value of 2.5.

$$\Omega_{oo} = 2.5$$

This value is almost 5% higher than the exact eigenvalue.

Lord Rayleigh suggested the possibility of changing equation (1) to

(2) $$W(r) \simeq W_a(r) = A(a^k - r^k)$$

The Rayleigh-Ritz method is applied to obtain

(3) $$\Omega_{oo} = \Omega_{oo}(k)$$

Equation (3) constitutes an upper bound.

(4) $$\frac{\partial \Omega_{oo}}{\partial k} = 0$$

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With equation (4) the value of the fundamental frequency coefficient can be optimized; the actual value of Ω_{00} = 2.41 is less than 0.3% higher than the exact result.

The method has been popularized in the last five years [3-5]. The approach, now known as the Rayleigh-Schmidt method [6, 7], has been extended to the solution of the Helmholtz equation in the case of two-dimensional domains of complicated geometry [8] and also to more complex structural vibrations problems [9].

Certainly the approximation can be improved.

$$W_a(r) = \sum_{i=o}^{I} A_i(a^k - r^k)r^i \tag{5}$$

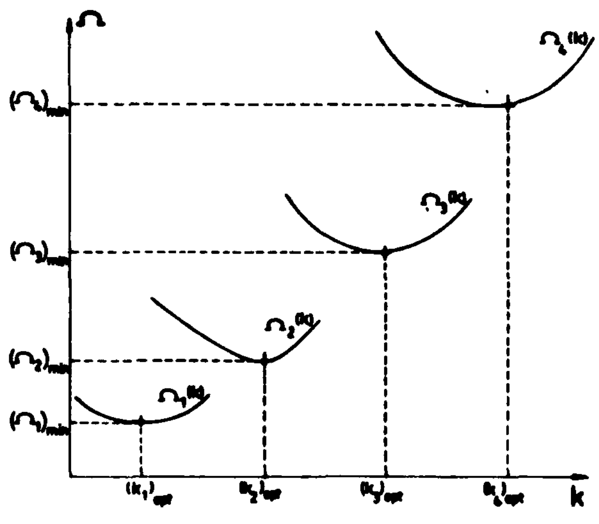
In the case of a circular membrane the exact eigenvalue can almost be obtained from the first two terms of equation (5).

But it has been pointed out recently [10] that higher eigenvalues can also be optimized by requiring

$$\frac{\partial \Omega_{oi}}{\partial k} = 0 \quad (i = 0, 1 \ldots I) \tag{6}$$

For each value of $(\Omega_{oi})_{min}$ a (k_i) optimum must be sought; see the figure.

It is important to note that the method can often be implemented on small desk computers and even programmable calculators.



Optimization of Eigenvalues by the Rayleigh-Schmidt Method.

THE FINITE ELEMENT METHOD AND LORD RAYLEIGH'S IDEA

The finite element method is undoubtedly one of the most efficient tools in computational mechanics. It permits practically all problems of continuum mechanics to be presented in an algorithmic form suitable for solution on a digital computer [11].

There is no question that the tremendous success of the finite element method is due in great part to the digital computer. On the other hand, optimization is always a sought after goal. The finite element method has been successfully optimized in order to achieve maximum precision and low computation costs. Among the philosophies that have been pursued to this end are maintaining a constant number of shape functions and successively decreasing element size, increasing the number of shape functions while keeping the finite element net constant, and optimizing element distribution.

Following Rayleigh's proposal in equation (2), a new procedure has recently been attempted [12]. The discretization error is minimized by including an unknown exponential parameter k in shape functions used to calculate natural frequencies or critical loads when the finite element method is formulated using the Rayleigh-Ritz approach. This formulation yields upper bounds; numerical minimization of the eigenvalues with respect to the parameter k permits optimization of the eigenvalues under study.

Admittedly there is room for considerable work in this area. Preliminary investigations of vibration and elastic stability eigenvalue problems make clear that the k optimization procedure results in a small number of elements with accuracy equivalent to that achieved when the region is subdivided into many more elements. In other words, the same accuracy can be obtained with a small or medium computer and a small number of elements as with a large computer and a dense net.

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LITERATURE REVIEW: survey and analysis of the Shock and Vibration literature

The monthly Literature Review, a subjective critique and summary of the literature, consists of two to four reviews each month, 3,000 to 4,000 words in length. The purpose of this section is to present a "digest" of literature over a period of three years. Planned by the Technical Editor, this section provides the DIGEST reader with up-to-date insights into current technology in more than 150 topic areas. Review articles include technical information from articles, reports, and unpublished proceedings. Each article also contains a minor tutorial of the technical area under discussion, a survey and evaluation of the new literature, and recommendations. Review articles are written by experts in the shock and vibration field.

OPTIMIZATION OF STRUCTURES UNDER SHOCK AND VIBRATION ENVIRONMENT

S.S. Rao*

Abstract. Structural optimization problems involving dynamic response calculations are classified according to the physical nature of the problem and the major behavior constraint considered. This article contains a summary of recent work in each class. Recent research on optimization techniques, including approximate analysis methods, multilevel design techniques, and multi-objective design procedures, is also presented. Structural optimization problems that need further investigation are summarized.

A general structural optimization problem deals with the minimization of an objective function $f(\vec{x})$ subject to the constraints $g_j(\vec{x}) \leq 0$, $j=1,2,\ldots m$ where $\vec{x}$ denotes the vector of design variables $(x_1,x_2,\ldots,x_n)$. Some problems include a set of equality constraints of the form $\ell_j(\vec{x})=0$ in addition to the inequality constraints $g_j(\vec{x})$. In a class of problems known as multi-objective optimization problems the function $f(\vec{x})$ is treated as a vector. Most structural optimization investigations consider only one objective function with no equality constraints. In some cases the design variables x_i are considered functions of a parameter, such as a spatial coordinate; the problem then is known as a trajectory optimization problem.

This paper presents a review of recent work in the field of structural optimization with dynamic constraints. The following types of problems are identified: optimization involving natural frequency constraints, optimization with dynamic response restrictions, optimum design of isolators and absorbers, optimization of vehicle suspensions, optimization with aeroelastic constraints, optimization involving random response quantities, optimization of active control systems, developments in optimization techniques and other types of structural optimization problems.

OPTIMIZATION INVOLVING NATURAL FREQUENCY RESTRAINTS

Structural and mechanical systems should be designed with natural frequency limitations to avoid failure due to resonance under the action of external forces. The minimum weight design of structures with frequency constraints has been considered [11,30,48]. The amount of material that would be necessary for an optimal bar or beam of fixed length and boundary conditions to attain an arbitrarily prescribed frequency can be disproportionately high; the design would be impractical. Study of the Kuhn-Tucker conditions for a structural optimal design problem with multi-frequency constraints has led to development of a new approach-sequential quadratic programming [32]. Minimization of structural mass subject to a fundamental frequency constraint and maximization of the fundamental frequency for a given structural mass has been considered in the design of rods and trusses [81]. Constantinou and Tadjbakhsh [9] presented a numerical method for solving distributed parameter structural problems in which repeated eigenvalues may occur. The method was illustrated with the design of a clamped-clamped column in which a repeated eigenvalue occurs.

Szymczak [75] considered the optimal design of thin-walled I-beams to maximize the natural frequency of torsional vibration using Pantryagin's maximum principle [75]. Maximization of the fundamental frequency of a thin-walled beam with coupled bending and torsional modes has been studied [20]. The profile of a beam of rectangular cross section supported by a Winkler-Pasternak foundation that will maximize the fundamental eigenfrequency or minimize the dynamic response of the beam has been determined [1]. The problem of optimal positioning of vibration supports to raise the fundamental natural frequency of vibration of a system has been studied [85]. Optimization of shallow arches has been studied by Plaut and his associates [56-58]. The form of the arch that maximizes the fundamental vibration frequency was investigated. Teschner [79] discussed the application of the optimal control theory to minimum weight design of continuous one-dimensional structural elements subject to eigenvalue constraints. The value of the eigenvalue is prescribed, as is its position in the sequence of the ordered eigenvalues specified. The optimal control problem of a linear distributed parameter

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system has been studied by employing the technique of shifted Legendre polynomial functions [51].

OPTIMIZATION WITH DYNAMIC RESPONSE RESTRICTIONS

Optimum design with constraints on dynamic response is important in structures subjected to periodic disturbances, impacts, gusts, blast waves, wind loading, and earthquakes. Reviews of optimal vibration reduction techniques for systems subject to harmonic excitation over a frequency range are available [59,60]. An efficient optimal design algorithm has been presented for minimizing the vibratory response of a multi-degree-of-freedom system under sinusoidal loading over several excitation frequencies [28]. Minimization of the forced vibrational response of structural and vibration isolation systems has been considered [54], as have design of high-speed planar mechanisms to minimize the dynamic reactions [37] and the optimization of a 100-ton bulkhead flat car with dynamic performance requirements [84].

Automated optimum design of transmission line towers, with base width and panel heights as design variables, has been studied [40]. A hydraulic shock absorber in a mechanical system has been designed using a SUMT for optimum response to a velocity shock [53]. The conditions for optimal support reaction for a viscoelastic beam or frame structure that undergoes forced vibrations have been derived [46]. Kitis [39] developed computational frequency response optimization methods for complex vibrating systems using passive control techniques. Reanalysis and modal techniques were used in the structural dynamic analysis phase of the design algorithm; optimization was carried out by a feasible directions approach. Typical applications of optimization techniques to the design of nonlinear structures subjected to dynamic loadings have been presented [5]. The applications are based on the use of the interactive software system OPTNSR. Optimization of a hemispherical containment shell with large deflection elastic-plastic response under internal blast has been studied [15].

OPTIMIZATION OF ISOLATORS AND ABSORBERS

Isolators reduce the unwanted effects of shock and vibration disturbances on critical elements of a mechanical system. Available isolator hardware has been described [14], as has the optimum design of vibration isolators [7,9,16,54,70]. Multi-objective design of shock isolators has been formulated as a game problem [16,70]. Cooperative game theory was used for the solution. The optimum design of a linear multistory structure with a seismic base isolation system consisting of rubber bearings and frictional elements has been considered [7]. It was shown that a small amount of friction increases the effectiveness of the system. The problem of the optimal base isolation system of multistory shear type buildings has been considered in a probabilistic sense [9]. For white noise ground accelerations the response of the structure relative to the base was minimized subject to constraints on the maximum displacements of the base.

The optimum design of absorbers has been considered [22,29,31,35,38,76]. Two frequency response optimization methods for vibrating systems were developed by appending absorbers to the original structure [38]. The optimal design algorithm was illustrated by a 39-degree-of-freedom helicopter model with discrete conventional absorbers and beam absorbers. An optimum design procedure for a dual dynamic absorber was described, and optimum values for its tuning and damping parameters were specified in graphs and by formulas for the design [22]. Soom and Lee [76] applied nonlinear programming to the optimum design of linear and nonlinear vibration absorbers for damped systems.

A feedback controller adapted for keeping a constant operating frequency and a compound dynamic absorber has been developed [29]. The absorber consists of several parallel nominally undamped absorbers with appropriate dispersion of their natural frequencies. Kasraie [31,32] used the state space method for the optimal design of vibration isolators and shock absorbers. Forcing functions, cost functions, and performance constraints were considered as functions of the state variables vector at some moving boundaries. Sixteen different shock absorbers with viscous damping and a bilinear spring was designed for optimum response to a shock of finite duration imposed by the supporting base.

OPTIMIZATION OF VEHICLE SUSPENSIONS

An overview of some design approaches for optimizing fatigue performance of suspension systems has been presented [2]. The effect of input in the vertical direction on the suspension under various driving conditions and road surfaces has been examined [12]. This study was performed while the steering wheel was being operated; the vehicle was driven on smooth and rough roads. The design of an optimum seat-suspension to protect drivers from incoming injurious vibrations in bounce, longitudinal, lateral, roll, and pitch modes has been presented [63].

The optimal design of passive suspensions, based upon statistical analysis of vehicle vibrations and dynamic loads, has been considered using the method of monotonicity analysis [43]. The simplicity of the resulting computations allowed a fast and inexpensive post-optimality parametric study. Formulas based on the minimization of mean-squared tire forces on random roads have been developed for the spring and damper rates in conventional car suspensions [78]. An optimal design has been proposed [80] that can be used in suspension designs to maximize the performance of a given motorcycle suspension. Several control criteria in the suspension system of a vehicle were established according to the theory of random vibration; a multi-objective decision procedure was presented [26]. A vehicle suspension dynamic response design sensitivity analysis and optimization technique has been presented and illustrated [18].

OPTIMIZATION WITH AEROELASTIC CONSTRAINTS

The concept of aeroelastic tailoring was introduced [55] in the development of forward-swept-wing aircraft. According to this concept, the optimization problem is formulated by considerin~ ·ll of the variables in addition to the fiber orientation angles. A method of synthesizing digital active flutter suppression controllers using optimal output feedback has been presented [24]. Determination of flutter frequencies and flutter boundary pressures of conical shells was carried out using finite element analysis [73]. At an optimum semi-vertex angle a given conical shell of prescribed length and initial radius offers maximum resistance to flutter.

The weight minimization of a flat rectangular panel of arbitrary aspect ratio placed in a high supersonic flow field and subjected to a flutter speed constraint has been studied [6]. Wang and Seireg [88] described an optimization procedure for blade designs of a helicopter rotor that maximizes hover horsepower while assuring satisfactory forward flight performance. A method has been presented for the optimum design of aircraft wing structures subjected to landing loads [67]. The stresses developed in the wing during landing are computed by considering the interaction between landing gear and flexible airplane structure.

OPTIMIZATION OF STRUCTURES WITH ACTIVE CONTROLS

The optimal open-loop control theory and its application to tall buildings under earthquake excitation have been studied [45]. An active tendon control system and an active mass damper system were investigated. The earthquake ground acceleration was modeled as both stationary and nonstationary random processes. The characteristics of vibration controllers have been optimized by the property of optimal control force obtained by optimal control theory [89]. A stationary Gaussian colored noise was used. Both straight beam and bent beam structures were considered. A time-domain parameter optimization algorithm for control systems has been presented [87]. A feedback controller was developed to maintain the constant operating frequency of a system [29]. The problem of active protection of continuous vibrating structures has been developed [44] using optimal control theory.

A method for vibration control of large space structures by simultaneous integration of the structure and control design to reduce structural response under a disturbance has been presented [41]. The objective function was the weight of the structure with a constraint on the damping parameter of the closed-loop system. A procedure for checking whether small changes in a structure have the potential to significantly enhance its optimized vibration control system has been presented [21]. Lamberson and Yang [49] studied the problem of optimization using lattice plate elements for feedback control of space structures. Reduced order controller design models have been developed using modal cost analysis to rank the modes corresponding to different sets of structural parameters.

OPTIMIZATION OF SYSTEMS INVOLVING RANDOM PARAMETERS

Whenever parameters affecting a design problem such as material properties and external loads are random in nature, the optimization problem must be formulated within a reliability framework. A direct search optimization technique has been carried out to select optimal bearing stiffness and the bearing spacing of an elastically supported lathe spindle-workpiece system subjected to random cutting forces [71]. The stochastic partial differential equation characterizing the behavior of the system was formulated from the Euler-Bernoulli equation. The optimum design of antenna structures subjected to random excitations and design requirements specified in a probabilistic manner have been considered [25]. An optimum method for generating pulse trains corresponding to the random excitation motions based on structural response has been studied [72]. An optimal design for suspension systems using statistical analysis of vehicle vibrations and dynamic loads has been presented [26,43].

Lin [45] studied the optimal open-loop control theory and its applications to tall buildings under earthquake excitations. The earthquake ground acceleration was modeled as a stationary random process as well as a nonstationary random process. An optimum design for a linear multistory structure with a seismic base isolation system has been presented [7]. The stochastic response of the system was determined under a white noise ground acceleration. The optimum design of seismic-resistant planar rectangular braced and unbraced steel frames has been studied [4]. Constantinou and Tadjbakhsh [10] considered the optimum design of a first story damping system of a multistory shear type structure subjected to stationary white noise ground acceleration. A probabilistic methodology has been developed for the reliability analysis and cost optimization of fatigue-critical components under scheduled inspection maintenance in service [8]. The global criterion, utility function, game theory, goal programming, goal attainment, bounded objective function, and lexicographic methods of multi-objective optimization methods have been presented by Rao [64] in the context of optimum design of a cantilever beam subjected to a stochastic base excitation.

OTHER OPTIMIZATION PROBLEMS

The optimization of machine tool structures subjected to dynamic response constraints has been considered [66,68,82]. Weizhong [82] analyzed the wheel head of a universal cylindrical grinding machine using a structural dynamics method; he optimized the design with the receptance of the system as the objective. Rao and Grandhi [66,68] considered the optimum design of a radial drilling machine and planing machine structures with natural frequency constraints. The optimality conditions for locating additional supports to restrict the dynamic response of a rigid perfectly plastic cylindrical shell subjected to an initial transverse velocity have been derived [47]. The optimum vibration control of a flexible transmission shaft operating over a speed range encompassing several critical speeds has been considered [36].

Rakheja and Sankar [62] investigated possibilities and limitations of tailoring blade mass and stiffness distributions to provide an optimum blade design in terms of weight, inertia, and dynamic characteristics. The optimal control problem of a linear distributed parameter system has been studied using the technique of shifted Legendre polynomial functions [51]. A new design concept of a self-optimizing support system for a rotating shaft has been proposed [23].

The possibility of minimizing the angular vibration response of selected points on an optical bench by redistributing the mass has been studied [86]. The governing equations were presented in a form suitable for application of the Pontryagin maximum principle; the beam cross sectional area played the role of the control function. The topological optimization of finite element idealization has been considered by minimizing the total potential energy, the Rayleigh quotient, and the energy quotient for the static equilibrium, free vibration, and Euler buckling problems, respectively [74]. The optimization of structures under dynamic forces has been considered by treating the direction of the force as a random variable [52].

DEVELOPMENTS IN OPTIMIZATION TECHNIQUES

Research on computational methods of interest for static and dynamic systems with regard to engineering applications has been summarized [50]. Wardi and Polak [83] presented a nondifferentiable optimization algorithm for the solution of optimal design problems with eigenvalue inequality constraints. An efficient iterative eigenvector technique for optimization analysis has been presented [27]. Two methods of optimum structural design in dynamic response have been presented [90]. The validity and effectiveness of the methods were shown in several numerical examples [90]. The application of complementary geometric programming in engineering design has been demonstrated by Rao [69]. Developments toward a general multilevel optimization capability and results for a three-level structural optimization have been described [77]. The method is based on partitioning a structure into a number of substructuring levels.

Several nonlinear multi-objective optimization techniques have been presented and illustrated [16,34,70]. The game theory approach was a better technique than other ones. The multi-criterion structural optimization problem has been stated as minimization of the maximum of a set of weighted criteria [3]. Multiple objectives were identified in the design of a vehicle suspension system [26]; the problem was solved according to multi-objective decision methods.

Efforts have also been directed toward the development of sensitivity analysis techniques in optimization [61]. A computer-oriented method and sensitivity analysis procedure have been presented for the optimal design of planar, constrained dynamic systems [33], as have design sensitivity analyses with general boundary conditions for static response problems and linear dynamic systems [17].

Grandhi and Haftka [19] surveyed structural shape optimization and emphasized techniques dealing with shape optimization of the boundaries of two- and three-dimensional bodies. The dependence of static response and eigenvalues on the shapes of plates and plane elastic solids has been characterized [65]. The optimization was conducted by treating the shape of elastic bodies as design variables.

CONCLUSION

This review of recent work on structural optimization under shock and vibration environments indicates that the following problems need further investigation:

- the solution of design problems with discrete or integer design variables
- reliability-based design problems involving stochastic processes with non-Gaussian inputs.
- the application of multilevel and decomposition techniques for the solution of large-scale design problems with dynamic constraints

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BOOK REVIEWS

INTRODUCTORY COURSE ON THEORY AND PRACTICE OF MECHANICAL VIBRATIONS

J.S. Rao and K. Gupta
Halsted Press
John Wiley & Sons, Inc., New York, NY
ISBN 0470-20076-6
1984, 395 pages, $41.95

This book is intended as an undergraduate text in mechanical vibrations. The standard material is clearly presented. There are ample examples and homework problems. The book reflects well the practice of vibration engineering.

In terms of computational techniques mixed (transfer matrix) methods are emphasized; on the other hand treatment of the displacement (stiffness) method is sketchy. Even at the undergraduate level, exposure to the process of assembling a stiffness matrix can be of value. It would be useful if an introductory text treated in some detail the different types of mass matrices.

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VIBRATION DAMPING

A.D. Nashif, D.I.G. Jones, J.P. Henderson
Wiley-Interscience Pub.
John Wiley & Sons, Inc., New York, NY
ISBN 0-471-86772-1
1985, 453 pages, $51.50

Structures and machines are designed to meet innumerable criteria which are defined by their uses. These uses expose them to certain external and internal dynamic loads resulting from movement(s) within or outside the structure. These loads can produce serious noise and vibration problems. Vibration control is the technology available for changing mode shapes, moving resonance peaks, reducing the excitation forces, and reducing the height of resonance peaks. The technique of reducing resonance peaks requires a technology which reduces the excitation magnitude or makes geometric changes in the structure. The vibratory energy in the structure must be dissipated before it generates high resonant amplitudes. This is the art and science of what damping is, either by introducing it into the structure using viscoelastic materials or techniques which dissipate the energy.

Only a few notable books have been published which are devoted to damping (for example Lazan, Damping of Materials and Members in Structural Mechanics and Ruzicka, Structural Damping). These books contain 1950s and '60s vintage technology. Since this time damping has been successfully applied in many fields of engineering. Damping technology has reached a state of maturity to take its place as a practical design tool to control resonant vibration problems. Vibration Damping brings together this information for the reader to apply this technology in a systematic manner.

Vibration Damping contains seven chapters. The first chapter describes the fundamentals and theory of vibration control using viscoelastic damping materials. The theory is not so detailed to preclude its application in practical situations or serve as a guide to explain or help in the understanding of experimental data and/or semi-empirical predictions. Chapter 1 also presents techniques used to analyze structural response. In the following chapter the discussion centers on the characterization of damping in materials and structures. The terms loss factor, storage modulus, and loss modulus are introduced. Their relationship to representing the dynamic properties of viscoelastic materials is shown. Chapter three contains additional discussion on the storage modulus and loss factor and the effects which environment (temperature, dynamic load, frequency, preload, etc.) has on them. The reduced temperature nomogram is introduced in this chapter and how it characterizes a damping material's properties.

The fourth chapter discusses in more detail the techniques used to analyze structural response and how damping modifies the dynamic properties. The discussion starts with simple single degree of freedom systems and is expanded to more complex systems. Discrete damping devices, such as tuned dampers and links, are considered in Chapter 5. This chapter also contains a section on applications and examples to give the reader a feel for how these devices are applied in practice. Chapter 6 discusses the subject of surface damping treatments: analyzing/analysis methods, environmental effects, bonding techniques, and extensional, shear, and multiple layer treatments. Techniques for measuring damping properties are covered in Chapter 6 as well as an excellent section on real-world applications. The last chapter contains design data sheets for a large number of commercially-available viscoelastic materials.

Three of the premier damping experts in the world have collaborated to put together this excellent text. Anyone who is interested in vibration and noise control will not only appreciate this book for the information it contains but also learn the steps needed to implement a successful damping treatment. This book is a must for anyone involved in solving vibration and noise problems.

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METHODS AND MEANS OF EXPERIMENTAL ANALYSIS OF THE DYNAMICS OF PRECISE TAPE DRIVES

P.A. Varanauskas, A.K. Kurtinaitis, K.M. Ragulskis
Moksłas Publ., Vilnius Lithuanian SSR
1982, 102 pages

Mechanical vibrations can exert an undesirable influence on the accuracy of recording and sound reproduction. This book examines questions dealing with vibration measurement and experimental analysis of dynamics of precise tape drive mechanisms used in such magnetic recording apparatus as data storage devices, control systems, and equipment used in automation and computation technology. The book also examines the feasibility of using these methods for the vibration analysis of flexible disks, drums, and weaving machines. Emphasis is on tape drives.

This 102 pages include two chapters. The first deals with the measurement of vibrations experienced by a moving tape in three-dimensional space and interacting with elements of associated mechanisms. Topics included in the first chapter are:

General principles of vibration measurement

Contactless methods for measuring tape vibrations

Examples of contactless methods for measuring vibrations of thin, flexible bodies

Contact methods for measuring vibrations

The measurement of vibrations of a moving coordinate with the aid of a light beam

Calibration of photoelectric measuring devices for the measurement of tape vibrations

Arrangements for the determination of relationships between various types of tape vibrations

Arrangements for the creation of oriented vibrations in magnetic tapes relative to groups of recording and reproducing heads

The application of methods for the measurement of vibrations in tapes

The use of methods and sources for the measurement of mechanical vibrations for the protection against false signals in magnetic recording

The second chapter deals with vibration measuring methods for flexible members (tapes) in tension. Major topics include:

Problems dealing with the measurement of tension in flexible moving bodies

Contact methods for measuring tension vibrations in flexible ribbon-like elements

Contactless methods for measuring tension vibrations in flexible, ribbon-like elements

The use of tension vibration measuring methods in the analysis of mechanisms with flexible connections

The book is concise. The individual methods are illustrated with clear schematics. The components making up the various schematics are for the most part not described in detail. The book is more a digest than a specific source of vibration measuring methods for moving tapes. The methods presented are not unique. However, having them assembled in one volume dealing with a fairly specific subject area is useful.

In one sense the book appears to be somewhat in a vacuum. This is because all of the 62 references given at the end are from the USSR. The subject area, however, is not unique to USSR. It appears therefore that the authors do not have access to western sources in this subject area.

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SHORT COURSES

APRIL

FUNDAMENTAL ASPECTS OF HYPERVELOCITY IMPACT AND SHAPED-CHARGE PHENOMENA

Dates: April 7-11, 1986
Place: Baltimore, MD
Objective: The course is designed for novices in the field of hypervelocity impact. It will provide a basic introduction to theoretical and experimental aspects of hypervelocity impact, including shaped-charge phenomena. Major topics to be covered include: physics of explosives; fundamentals of shaped-charges; explosive/metal interaction; analytical penetration and hole growth models; experimental techniques in hypervelocity impact studies; computational aspects of hypervelocity impact and shaped-charges.

Contact: Computational Mechanics Associates, P.O. Box 11314, Baltimore, MD 21239 - (301) 435-1411.

MACHINERY DIAGNOSTICS

Dates: April 8-11, 1986
Place: Atlanta, Georgia
Dates: May 5-9, 1986
Place: Carson City, Nevada
Dates: June 16-20, 1986
Place: Carson City, Nevada
Dates: June 24-27, 1986
Place: Denver, Colorado
Objective: This seminar instructs rotating machinery users on transducer fundamentals, the use of basic diagnostic techniques, and interpreting industry-accepted vibration data formats to diagnose common rotating machinery malfunctions. The seminar includes class demonstrations, case histories, and a hands-on workshop that allows participants to diagnose malfunctions on demonstrator rotor systems.

Contact: Bently Nevada's Customer Information Center, P.O. Box 157, Minden, NV 89437 -800-227-5514, Ext. 9682.

MACHINERY MONITORING

Dates: April 22-24, 1986
Place: Philadelphia, Pennsylvania
Dates: May 20-22, 1986
Place: Chicago, Illinois
Dates: June 10-12, 1986
Place: Anaheim, California
Objective: The seminar focuses on the principles of vibration measurement for rotating machinery monitoring. Subjects covered in the seminar include troubleshooting, calibration and maintenance of monitoring systems, and the applications and installation of displacement, velocity, and acceleration transducers.

Contact: Bently Nevada's Customer Information Center, P.O. Box 157, Minden, NV 89437 -800-227-5514, Ext. 9682.

DYNAMIC BALANCING

Dates: April 23-24, 1986
June 18-19, 1986
Place: Columbus, Ohio
Objective: Balancing experts will contribute a series of lectures on field balancing and balancing machines. Subjects include: field balancing methods; single, two and multi-plane balancing techniques; balancing tolerances and correction methods. The latest in-place balancing techniques will be demonstrated and used in the workshops. Balancing machines equipped with microprocessor instrumentation will also be demonstrated in the workshop sessions, where each student will be involved in hands-on problem-solving using actual armatures, pump impellers, turbine wheels, etc., with emphasis on reducing costs and improving quality in balancing operations.

Contact: R.E. Ellis, IRD Mechanalysis Inc., 6150 Huntley Road, Columbus, OH 43229 -(614) 885-5376.

MACHINERY VIBRATION ANALYSIS II

Dates: April 28 - May 2, 1986
Place: Syria, Virginia
Objective: The objective of this course is to expose participants to advanced techniques of vibration analysis using single-and dual-channel

FFT analyzers. These techniques include analysis of spectrum, time, frequency, and orbital domain; modal analysis; coherence, frequency response functions, and synchronous time averaging; and amplitude, phase, and frequency modulation. Data processing procedures are reviewed. All techniques are illustrated with examples and case histories of industrial machinery. Instrumentation necessary to implement the techniques is available for use by participants during informal workshops; taped data from actual industrial machinery are used during these workshops.

Contact: Dr. Ronald L. Eshleman, Director, The Vibration Institute, 101 West 55th Street, Suite 206, Clarendon Hills, IL 60514 - (312) 654-2254.

MAY

VIBRATION AND SHOCK SURVIVABILITY, TESTING, MEASUREMENT, ANALYSIS, AND CALIBRATION

Dates: May 12-16, 1986
Place: Detroit, Michigan
Dates: June 2-6, 1986
Place: Santa Barbara, California
Dates: August 18-22, 1986
Place: Santa Barbara, California
Dates: October 6-10, 1986
Place: Boston, Massachusetts
Objective: Topics to be covered are resonance and fragility phenomena, and environmental vibration and shock measurement and analysis; also vibration and shock environmental testing to prove survivability. This course will concentrate upon equipments and techniques, rather than upon mathematics and theory.

Contact: Wayne Tustin, 22 East Los Olivos Street, Santa Barbara, CA 93105 -(805) 682-7171.

ROTATING MACHINERY VIBRATIONS

Dates: May 19-21, 1986
Place: Orlando, Florida
Objective: This course provides participants with an understanding of the principles and practices of rotating machinery vibrations and the application of these principles to practical problems. Some of the topics to be discussed are: theory of applied vibration engineering applied to rotating machinery; vibrational stresses and component fatigue; engineering instrumentation measurements; test data acquisition and diagnosis; fundamentals of rotor dynamics theory; bearing static and dynamic properties; system analysis; blading analysis; life estimation; practical rotor blading-bearing dynamics examples and case histories; rotor balancing theory; balancing of rotors in bearings; rotor signature analysis and diagnosis; and rotor-bearing failure prevention.

Contact: Dr. Ronald L. Eshleman, Director, The Vibration Institute, 101 West 55th Street, Suite 206, Clarendon Hills, Il 60514 - (312) 654-2254.

APPLIED VIBRATION ENGINEERING

Dates: May 19-21, 1986
Place: Orlando, Florida
Objective: This intensive course is designed for specialists, engineers and scientists involved with design against vibration or solving of existing vibration problems. This course provides participants with an understanding of the principles of vibration and the application of these principles to practical problems of vibration reduction or isolation. Some of the topics to be discussed are: fundamentals of vibration engineering; component vibration stresses and fatigue; instrumentation and measurement engineering; test data acquisition and diagnosis; applied spectrum analysis techniques; spectral analysis techniques for preventive maintenance; signal analysis for machinery diagnostics; random vibrations and processes; spectral density functions; modal analysis using graphic CRT display; damping and stiffness techniques for vibration control; sensor techniques for machinery diagnostics; transient response concepts and test procedures; field application of modal analysis for large systems; several sessions on case histories in vibration engineering; applied vibration engineering state-of-the-art.

Contact: Dr. Ronald L. Eshleman, Director, The Vibration Institute, 101 West 55th Street, Suite 206, Clarendon Hills, IL 60514 - (312) 654-2254.

VIBRATION DAMPING TECHNOLOGY

Dates: May 19-23, 1986
Place: Reno, Nevada
Dates: July 14-17, 1986
Place: Montreal, Canada
Dates: September 15-19, 1986
Place: Dayton, Ohio
Dates: January, 1987
Place: Clearwater, Florida

Objective: Basics of theory and application of viscoelastic and other damping techniques for vibration control. The courses will concentrate on behavior of damping materials and their effect on response of damped systems, linear and nonlinear, and emphasize learning through small group exercises. Attendance will be strictly limited to ensure individual attention.

Contact: David I. Jones, Damping Technology Information Services, Box 565, Centerville Branch USPO, Dayton, OH 45459-9998 - (513) 434-6893.

JUNE

VIBRATION CONTROL
Dates: June 9-13, 1986
Place: San Diego, CA
Objective: Participants in this course should leave with an understanding of the options available for vibration control, including general design considerations and such control techniques as isolation and damping. Lectures provide a sound review of vibration theory and develop the principles of vibration isolation and damping as they apply to particular design problems. Examples and case histories are used to illustrate design approaches; participants can solve problems during workshops.

Contact: Dr. Ronald L. Eshleman, Director, The Vibration Institute, 101 West 55th Street, Suite 206, Clarendon Hills, IL 60514 - (312) 654-2254.

JULY

FLOW-INDUCED OSCILLATIONS IN ENGINEERING SYSTEMS
Dates: July 1-2, 1986
Place: Bethlehem, Pennsylvania
Objective: The aim of this course is to provide the practicing engineer with a means of identification and assessment of the crucial flow mechanisms and flow-structure interactions leading to vibration and noise. Throughout the course, emphasis will be given to physical and practical interpretation of the common features of problems occurring in mechanical-, aerospace-, hydraulic-, and wind-engineering areas. The course will concentrate on the physical principles of identification, analysis, and attenuation (or cure) of oscillations, followed by practical case studies, during which the instructor will cover examples from a variety of applications.

Contact: Dr. James Brown, Lehigh Director of Continuing Education, Office of Continuing Education, 219 Warren Square, Lehigh University, Bethlehem, PA 18015 - (215) 861-3934.

FINITE ELEMENTS IN MECHANICAL AND STRUCTURAL DESIGN A: LINEAR STATIC ANALYSIS
Dates: July 14-18, 1986
Place: Ann Arbor, Michigan
Objectives: Presents energy formulation and modeling concepts. For engineers requiring stress, strain and displacement information. Attendees use personal computers to develop models of several problems and use MSC/NASTRAN in laboratory sessions. No previous finite element experience is required.

Contact: William J. Anderson, Engineering Summer Conferences, 200 Chrysler Center, North Campus, The University of Michigan, Ann Arbor, MI 48109 - (313) 764-8490

MODAL TESTING OF MACHINES AND STRUCTURES
Dates: July 14-18, 1986
Place: Rindge, New Hampshire
Objective: Vibration testing and analysis associated with machines and structures will be discussed in detail. Practical examples will be given to illustrate important concepts. Theory and test philosophy of modal techniques, methods for mobility measurements, methods for analyzing mobility data, mathematical modeling from mobility data, and applications of modal test results will be presented.

Contact: Dr. Ronald L. Eshleman, Director, The Vibration Institute, 101 West 55th Street, Suite 206, Clarendon Hills, IL 60514 - (312) 654-2254.

ROTOR DYNAMICS
Dates: July 14-18, 1986
Place: Rindge, New Hampshire
Objective: The role of rotor/bearing technology in the design, development and diagnostics of industrial machinery will be elaborated. The

fundamentals of rotor dynamics; fluid-film bearings; and measurement, analytical, and computational techniques will be presented. The computation and measurement of critical speeds vibration response, and stability of rotor/bearing systems will be discussed in detail. Finite elements and transfer matrix modeling will be related to computation on mainframe computers, minicomputers, and microprocessors. Modeling and computation of transient rotor behavior and nonlinear fluid-film bearing behavior will be described. Sessions will be devoted to flexible rotor balancing including turbogenerator rotors, bow behavior, squeeze-film dampers for turbomachinery, advanced concepts in troubleshooting and instrumentation, and case histories involving the power and petrochemical industries.

Contact: Dr. Ronald L. Eshleman, Director, The Vibration Institute, 101 West 55th Street, Suite 206, Clarendon Hills, IL 60514 - (312) 654-2254.

ADVANCED TECHNIQUES FOR NOISE CONTROL

Dates: July 17-19, 1986

Place: Cambridge, Massachusetts

Objective: Among the topics to be covered are modern instrumentation for noise control, modal analysis, sound intensity applications, active techniques for noise control, structural and vibration transmission, and airport noise and monitoring systems.

Contact: Institute of Noise Control Engineering, P.O. Box 3206 Arlington Branch, Poughkeepsie, NY 12603.

FINITE ELEMENTS IN MECHANICAL AND STRUCTURAL DESIGN B: DYNAMIC AND NONLINEAR ANALYSIS

Dates: July 21-25, 1986

Place: Ann Arbor, Michigan

Objective: Covers vibration, material nonlinearities, and geometric nonlinearities. Includes normal modes, transient response, Euler buckling, and heat conduction. Attendees use personal computers to develop models of several problems and use MSC/NASTRAN in laboratory sessions.

Contact: William J. Anderson, Engineering Summer Conferences, 200 Chrysler Center, North Campus, The University of Michigan, An Arbor, MI 48109 (313) 764-8490

FINITE ELEMENTS IN MECHANICAL AND STRUCTURAL DESIGN C: DESIGN SENSITIVITIES, CYCLIC SYMMETRY AND DMAP

Dates: July 28-August 1, 1986

Place: Ann Arbor, Michigan

Objective: Presents the use of design sensitivities and optimization (2 days), cyclic symmetry (1 day), DMAP programming (2 days). Attendees use MSC/NASTRAN to run sample problems in each topic. These methods greatly enhance the productivity and are now becoming widely used.

Contact: William J. Anderson, Engineering Summer Conferences, 200 Chrysler Center, North Campus, The University of Michigan, Ann Arbor, Michigan 48109 - (313) 764-8490.

AUGUST

DESIGN AND ANALYSIS OF ENGINEERING EXPERIMENTS

Dates: August 4-15, 1986

Place: Ann Arbor, Michigan

Objective: Recent developments in the field of testing, methods for designing experiments, interpretation of test data, and better utilization of the existing data. Design of experiments with a small number of test pieces or runs with high dispersion is emphasized. Obtaining maximum information from limited test data is stressed.

Contact: William J. Anderson, Engineering Summer Conferences, 200 Chrysler Center, North Campus, The University of Michigan, Ann Arbor, Michigan 48109 - (313) 764-8490.

MACHINERY VIBRATION ANALYSIS I

Dates: August 19-22, 1986

Place: New Orleans, Louisiana

Dates: November 11-14, 1986

Place: Chicago, Illinois

Objective: This course emphasizes the role of vibrations in mechanical equipment instrumentation for vibration measurement, techniques for vibration analysis and control, and vibration correction and criteria. Examples and case histories from actual vibration problems in the petroleum, process, chemical, power, paper, and pharmaceutical industries are used to illustrate techniques. Participants have the opportunity to become familiar with these techniques during the workshops. Lecture topics include: spectrum, time domain, modal, and orbital analysis; determination of natural frequency, resonance, and critical speed; vibration analysis of specific mechanical components, equipment, and equipment trains; identification of machine forces and frequencies; basic rotor dynamics including fluid-film bearing characteristics, instabilities, and response to mass unbalance; vibration correction including balancing; vibration control including isolation and damping of installed equipment; selection and use of instrumentation; equipment evaluation techniques; shop testing; and plant predictive and preventive maintenance. This course will be of interest to plant engineers and technicians who must identify and correct faults in machinery.

Contact: Dr. Ronald L. Eshleman, Director, The Vibration Institute, 101 West 55th Street, Suite 206, Clarendon Hills, IL 60514 - (312) 654-2254.

VIBRATIONS OF RECIPROCATING MACHINERY

Dates: August 19-22, 1986
Place: New Orleans, Louisiana

Objective: This course on vibrations of reciprocating machinery includes piping and foundations. Equipment that will be addressed includes reciprocating compressors and pumps as well as engines of all types. Engineering problems will be discussed from the point of view of computation and measurement. Basic pulsation theory --including pulsations in reciprocating compressors and piping systems -- will be described. Acoustic resonance phenomena and digital acoustic simulation in piping will be reviewed. Calculations of piping vibration and stress will be illustrated with examples and case histories. Torsional vibrations of systems containing engines and pumps, compressors, and generators, including gearboxes and fluid drives, will be covered. Factors that should be considered during the design and analysis of foundations for engines and compressors will be discussed. Practical aspects of the vibrations of reciprocating machinery will be emphasized. Case histories and examples will be presented to illustrate techniques.

Contact: Dr. Ronald L. Eshleman, Director, The Vibration Institute, 101 West 55th Street, Suite 206, Clarendon Hills, IL 60514 - (312) 654-2254.

ABSTRACTS FROM THE CURRENT LITERATURE

ABSTRACT CONTENTS

AVAILABILITY OF PUBLICATIONS ABSTRACTED

None of the publications are available at SVIC or at the Vibration Institute, except those generated by either organization.

Periodical articles, society papers, and papers presented at conferences may be obtained at the Engineering Societies Library, 345 East 47th Street, New York, NY 10017; or Library of Congress, Washington, D.C., when not available in local or company libraries.

Government reports may be purchased from National Technical Information Service, Springfield, VA 22161. They are identified at the end of bibliographic citation by an NTIS order number with prefixes such as AD, N, NTIS, PB, DE, NUREG, DOE, and ERATL.

Ph.D. dissertations are identified by a DA order number and are available from University Microfilms International, Dissertation Copies, P.O. Box 1764, Ann Arbor, MI 48108.

U.S. patents and patent applications may be ordered by patent or patent application number from Commissioner of Patents, Washington, D.C. 20231.

Chinese publications, identified by a CSTA order number, are available in Chinese or English translation from International Information Service, Ltd., P.O. Box 24683, ABD Post Office, Hong Kong.

Institution of Mechanical Engineers publications are available in U.S.: SAE Customer Service, Dept. 676, 400 Commonwealth Drive, Warrendale, PA 15096, by quoting the SAE-MEP number.

When ordering, the pertinent order number should always be included, not the DIGEST abstract number.

A List of Periodicals Scanned is published in issues, 1, 6, and 12.

MECHANICAL SYSTEMS

ROTATING MACHINES

86-532

Transient Response of Torsional Feedback Servomechanisms with Consideration of Vibration of Shafts

K. Nagaya, H. Kojima, K. Ohkawara, Y. Kumagai
Gunma Univ., Kiryu, Gunma 376, Japan

J. Sound Vib., 100 (2), pp 155-168 (May 22, 1985), 10 figs, 1 table, 6 refs

KEY WORDS: Shafts, Gears, Laplace transformation, Transient response

A closed loop torsional position control system consisting of shafts and gear mechanisms is described. The dynamic response of the system is investigated theoretically by application of the Laplace transform method. In the analysis the transformed equations for both electrical and mechanical systems is expressed in a matrix form, and the solution is determined directly by use of the residue theorem. The solution obtained gives the angles of rotation of the controlling body, gears, rotor, shafts and the torques of the shafts in the transient motion.

86-533

Multi Mass Drive Systems with Stepped Shafts

W. Nadolski, A. Pielorz, A. Mioduchowski
Polish Academy of Sciences, Warsaw, Poland

Meccanica, 20 (2), pp 164-170 (June 1985), 3 figs, 2 tables, 4 refs

KEY WORDS: Shafts, Torsional vibration, Variable cross section

A continuous model of a multi mass drive system with stepped shafts, loaded by external moments, is proposed and analyzed by means of one dimensional torsional waves. A procedure is developed for calculation of velocities, strains and displacements in an arbitrary cross-section of the shafts, and some necessary conditions for the stability of angular displacements are formulated.

86-534

Determination of the Optimal Balancing Head Location on Flexible Rotors Using a Structural Dynamics Modification Algorithm

Y.D. Kim, C.W. Lee
Korea Advanced Inst. of Science and Technology, Seoul, Korea

IMechE, Proc., 199 (C1), pp 19-25 (1985), 7 figs, 14 refs

KEY WORDS: Flexible rotors, Balancing techniques, Structural modification techniques

A simple and effective method to determine the optimal location of the balancing head and the amount of correction unbalance, adopting a structural dynamics modification approach, is presented and an example problem is solved. It is shown that the current approach yields results almost as accurate as those obtained by finite element analysis, while computational time and effort are remarkably reduced.

86-535

Stability of a Rotor Whose Cavity Has an Arbitrary Meridian and Is Partially Filled with Fluid

R. Wohlbrück
Westfalia Separator AG, Oelde, Fed. Rep. Germany

J. Vib., Acoust., Stress Rel. Des., Trans. ASME, 107 (4), pp 440-445 (Oct 1985), 5 figs, 2 tables, 13 refs

KEY WORDS: Rotors, Fluid-filled containers, Elastic supports, Stability

The stability of an elastically supported rotor spinning with constant angular velocity is studied. The rotor has a cavity of arbitrary meridian and is partially filled with an ideal fluid. The motions of the system are governed by linearized equilibrium conditions for the rotor and field equations as well as boundary conditions for the fluid. Due to the arbitrary shape of the meridian, it is not possible to solve the boundary value problem in closed form. Therefore a variational expression is developed which satisfies the boundary conditions naturally. The variational problem is solved approximately by the finite element method.

86-536

Forced Wave Motion of Liquid Partially Filling a High-Speed Rotor

J. Inoue, Y. Jinnouchi, Y. Araki

Kyushu Inst. of Technology, Sensuicho, Tobata, Kitakyushu 804, Japan
J. Vib., Acoust., Stress Rel. Des., Trans. ASME, 107 (4), pp 446-452 (Oct 1985), 10 figs, 17 refs

KEY WORDS: Rotors, Fluid-filled containers, Fluid-induced excitation

Wave motion of a liquid in a partially filled hollow cylindrical rotor, which rotates at a high speed and is forced to vibrate, is theoretically and experimentally investigated. Emphasis is placed on the analysis of a large wave motion in the liquid which may cause self-excited vibrations of the rotor.

86-537
Active Control of Vibrations in the Case of Asymmetrical High-Speed Rotors by Using Magnetic Bearings
E. Anton, H. Ulbrich
Fa. Knorr-Bremse GmbH Munchen, Fed. Rep. Germany
J. Vib., Acoust., Stress Rel. Des., Trans. ASME, 107 (4), pp 410-415 (Oct 1985), 4 figs, 3 tables, 12 refs

KEY WORDS: Rotors, Vibration isolation, Active isolation, Magnetic bearings

Rotor-bearing systems with long, fast running rotors and rotational symmetry disturbed in stiffness, damping and moments of inertia are investigated. Since a magnetic bearing is used as an actuator in a control circuit, vibrations of the system can be influenced in a desired way. A feedback control is designed with emphasis to the endangered modes of oscillation of the rotor system caused by parametrical excitation.

86-538
Calculation of Nonlinear Unbalance Response of Horizontal Jeffcott Rotors Supported by Ball Bearings with Radial Clearances
S. Saito
Ishikawajima-Harima Heavy Industries Ltd., Tokyo, Japan
J. Vib., Acoust., Stress Rel. Des., Trans. ASME, 107 (4), pp 416-420 (Oct 1985), 5 figs, 2 refs

KEY WORDS: Rotors, Ball bearings, Unbalanced mass response, Harmonic balance method

Nonlinear unbalance response of horizontal Jeffcott rotors supported by ball bearings with radial clearances are investigated. The method to calculate the nonlinear vibration of the rotor as well as the expression of the nonlinear bearing force are given using the numerical harmonic balance technique.

86-539
A Conical Beam Finite Element for Rotor Dynamics Analysis
L.M. Greenhill, W.B. Bickford, H.D. Nelson
Garrett Turbine Engine Co., Phoenix, AZ
J. Vib., Acoust., Stress Rel. Des., Trans. ASME, 107 (4), pp 421-430 (Oct 1985), 12 figs, 2 tables, 8 refs

KEY WORDS: Rotors, Beams, Conical bodies, Variable cross section, Finite element technique

The development of finite element formulations for use in rotor dynamics analysis has been the subject of many recent publications. These works have included the effects of rotatory inertia, gyroscopic moments, axial load, internal damping, and shear deformation. However, for most closed-form solutions, the element geometry has been limited to a cylindrical cross-section. This paper extends these previous works by developing a closed-form expression including all of the above effects in a linearly tapered conical cross-section element.

86-540
Response of Rotors Subjected to Random Support Excitations
R. Subbiah, R.B. Bhat, T.S. Sankar
Concordia Univ., Montreal, Quebec, Canada
J. Vib., Acoust., Stress Rel. Des., Trans. ASME, 107 (4), pp 453-459 (Oct 1985), 12 figs, 14 refs

KEY WORDS: Rotors, Rotating machinery, Base excitation, Power spectral density, Modal analysis

Response of rotor systems subjected to random support excitations is studied. The amplitude power spectral densities (PSD) due to random support excitations are obtained for rotor systems using modal analysis methods. The excitations are assumed to be stationary and Gaussian with a white noise type of PSD. Excitations through different supports are assumed to be statistically independent so that their cross correlations are zero. Results for rotors with various parametric combinations are presented.

RECIPROCATING MACHINES

86-541
On the Prediction of Impact Noise, Part VIII: Diesel Engine Noise
J.M. Cuschieri, E.J. Richards
Florida Univ., Boca Raton, FL
J. Sound Vib., 102 (1), pp 21-56 (Sept 1985), 48 figs, 14 refs

KEY WORDS: Diesel engines, Noise prediction

The noise energy radiated from a diesel engine due to combustion and piston slap excitation is investigated by considering single impacts. From the results obtained, possible methods of noise control are studied, and the expected results due to changes in the liner mounting to the engine frame, and the bearings of the camshaft for an injected engine, are compared to the measured noise levels.

METAL WORKING AND FORMING

86-542
A Trial on Direct Forming with Vibration
K. Chijiiwa, Y. Hatamura, T. Yoneyama
Chiba Inst. of Technology, Tokyo, Japan
Bull. JSME, 28 (240), pp 1308-1315 (June 1985) 9 figs, 2 tables, 3 refs

KEY WORDS: Vibratory techniques, Metal working

A new metal forming method in which metal material (99.7%A1) is solidified with vibration and directly formed at high temperatures is tested. A material consisting of fine and uniform crystalline grains is obtained. The refinement and uniformity of crystalline grain in the solidification process are most significant in this direct forming. It is shown that high quality material can be obtained by this energy-saving and process-saving method.

STRUCTURAL SYSTEMS

BRIDGES

86-543
Response of Slender Structural Members in Self-Excited Oscillation
M. Chi, J. Vossoughi
The Catholic Univ. of America, Washington, DC
J. Sound Vib., 101 (1), pp 75-83 (July 8, 1985) 5 figs, 10 refs

KEY WORDS: Bridges, Structural members, Cylindrical shells, Wind-induced excitation, Vortex shedding

The classical Hartlen-Currie model, originally developed for response of a circular rigid cylinder in subcritical flow, is modified and extended to be applied to other cross sections. Non-dimensional parameters characterizing any given section must be calibrated by reliable test data. The procedure is illustrated by a successful application to an H-shaped section, including a graphical representation of amplitude at various damping parameters. The results for a rigid cylinder are extended to represent a flexural beam with given end conditions. A summary of the procedure to compute the rms deflection in a supercritical flow is given through the application of random vibration theory.

86-544
Calibration of Bridge Fatigue Design Model
W.E. Nyman, F. Moses
Hardesty and Hanover, New York, NY
ASCE J. Struc. Engrg., 111 (6), pp 1251-1266 (June 1985) 8 figs, 5 tables, 19 refs

KEY WORDS: Bridges, Steel, Fatigue life

A structural reliability evaluation is performed of the current AASHTO fatigue specification for steel bridges. The reliability model incorporates uncertainties in vehicular loading, analysis, and fatigue life. Using the loading and fatigue life data a safety index is calculated using a level II reliability program. The study reviews the current specification in order to derive uniform reliability levels over the range of typical designs.

86-545
End-Bolted Cover Plates
F. Wattar, P. Albrecht, A.H. Sahli
Dar-Alhandasah, Beirut, Lebanon
ASCE J. Struc. Engrg., 111 (6), pp 1235-1249 (June 1985), 13 figs, 4 tables, 7 refs

KEY WORDS: Plates, Bridges, Welded joints, Fatigue life

Welding a cover plate to a rolled beam and high-strength bolting the loose ends with a friction-type connection increased the fatigue strength from Category E for end-welded cover plates to Category B. This method of construction has the potential of fatigue proofing cover plates on rolled beams while lowering their cost of fabrication. It utilizes existing technology and can be implemented at once.

BUILDINGS

86-546

Dynamic Analysis of a Forty-Four Story Building

B.F. Maison, C.F. Neuss

ASCE J. Struc. Engrg., 111 (7), pp 1559-1572 (July 1985), 11 figs, 3 tables, 9 refs

KEY WORDS: Multistory buildings, Seismic response

Extensive computer analysis of an existing 44-story steel frame high-rise building is performed to study the influence of various modeling aspects on the predicted dynamic properties and computed seismic response behaviors. Interpretations of the analysis results are provided. Conclusions are drawn regarding general results that are relevant to the analysis of other high-rise buildings.

86-547

Seismic Damage Analysis and Damage-Limiting Design for R/C Structures

Young-Ji Park

Ph.D. Thesis, Univ. of Illinois, Urbana-Champaign, 179 pp (1985), DA8511657

KEY WORDS: Buildings, Reinforced concrete, Earthquake damage, Damage prediction, Seismic design

A model for evaluating structural damage in reinforced concrete structures under earthquake ground motions is proposed. Damage is expressed as a linear combination of the maximum deformation and the effect of repeated cyclic loadings. Available static (monotonic) and dynamic (cyclic) test data are analyzed to evaluate the statistics of the appropriate parameters of the proposed model. A method of nonlinear random vibration technique is developed for obtaining the response statistics necessary for damage assessment.

86-548

Design of Connections for Precast Prestressed Concrete Buildings for the Effects of Earthquake

D.P. Clough

ABAM Engineers, Inc., Federal Way, WA

Rept. No. NSF/ENG-85004, 180 pp (Mar 1985), PB85-186914/GAR

KEY WORDS: Buildings, Reinforced concrete, Seismic design

Buildings designed in conformance with typical building code criteria will yield during a significant earthquake. A design methodology has been developed which takes into account quantitative estimates of plastic deformations and enables a more rational approach to connection detailing. A simple concept is used to estimate the maximum inelastic displacement at roof level. Results from other investigators are applied to estimate the number of reversed inelastic loading cycles which must be sustained during the response to a damaging earthquake.

86-549

Stochastic Evaluation of Seismic Structural Performance

R.H. Sues, Yi-Kwei Wen, A.H.-S. Ang

National Technical Systems/SMA Div., Newport Beach, CA

ASCE J. Struc. Engrg., 111 (6), pp 1204-1218 (June 1985), 8 figs, 4 tables, 23 refs

KEY WORDS: Multistory buildings, Seismic response

A method is presented for determining the probabilities of a structure sustaining various levels of damage due to seismic activity during its lifetime. Uncertainties in the loading and the structural response analysis are considered. The method is based on a nonlinear random vibration analysis and an analytical technique for evaluating the sensitivity of the response to various structural and load parameters.

86-550

Some Uniqueness Results Related to Soil and Building Structural Identification

F.E. Udwadia

Univ. of Southern California, Los Angeles, CA

SIAM J. Appl. Math., 45 (4), pp 674-685 (Aug 1985), 1 fig, 11 refs

KEY WORDS: Multistory buildings, Soil-structure interaction, Damping coefficients, Stiffness coefficients

The need for accurate predictions of the dynamic responses of soil and structural systems has led to the widespread use of forced vibration testing for obtaining knowledge of the dynamic properties of the systems under consideration. This paper is concerned with the uniqueness of the results in the identification of such properties. More specifically, the damping and stiffness distributions which are of importance in the linear range of response, have been investigated.

FOUNDATIONS

86-551

Seismic Modelling of Deep Foundations

Cheng-Hsing Chen

Ph.D. Thesis, Univ. of California, 127 pp (1984), DA8512778

KEY WORDS: Foundations, Soil-structure interaction, Seismic response

The hybrid modeling approach, which can effectively solve three-dimensional soil-structure interaction problems, is generalized herein to be applicable to deep foundations. This is achieved by partitioning the entire soil-structure system into a near-field and a far-field using a cylindrical interface positioned very close to the structure-soil interface. The resulting impedance matrix is fully-coupled, complex-valued and frequency-dependent and can be combined with any compatible near-field for the purpose of carrying out complex response analyses of foundations.

86-552

Rocking and Toppling of Block-Like Structures on Rigid or Flexible Foundations Subjected to Harmonic or Random Excitations

Aik-Siong Koh

Ph.D. Thesis, The Univ. of Texas, Austin, 160 pp (1984), DA8513241

KEY WORDS: Rigid foundations, Flexible foundations, Seismic excitation, Harmonic excitation, Random excitation

The rocking of a rigid rectangular block on a shaking foundation is examined. The foundation is either a rigid plane or a flexible (Winkler) foundation whose independent springs and dashpots separate from the block base when the springs are in tension. deterministic and random excitations are used to shake both types of foundation. The deterministic excitations are harmonic or earthquake records, while the random ones are modulated white noise or filtered white noise.

HARBORS AND DAMS

86-553

Earthquake Analysis and Response of Concrete Gravity Dams

G. Fenves, A.K. Chopra

Univ. of California, Berkeley, CA

Rept. No. UCB/EERC-84/10, NSF/CEE-84021, 240 pp (Aug 1984), PB85-193902/GAR

KEY WORDS: Dams, Concrete, Seismic analysis

Reservoir bottom materials are modeled approximately by a reservoir bottom that partially absorbs incident hydro-dynamic pressure waves. A general analytical procedure is developed to compute the response of concrete gravity dams to arbitrary earthquake ground motion including the simultaneous effects of dam-water interaction, dam-foundation rock interaction and reservoir bottom absorption. A simplified analytical procedure suitable for the preliminary design and safety evaluation of concrete gravity dams is developed.

ROADS AND TRACKS

86-554

A Structural Evaluation Methodology for Pavements Based on Dynamic Deflections

W. Uddin

Ph.D. Thesis, The Univ. of Texas, Austin, TX, 595 pp (1984), DA8513314

KEY WORDS: Pavements, Concrete, Computer programs

A framework for comprehensive structural evaluation of pavements based on dynamic deflections is presented. Self-iterative procedures are developed to estimate insitu Young's moduli of pavement layers by using the approach of inverse application of layered elastic theory to a dynamic deflection basin, and to estimate nonlinear strain-softening moduli of granular layers and subgrade. For flexible pavements, a temperature correction procedure is presented for the asphaltic concrete modulus. An indication of the structural capacity of existing pavement is obtained from the remaining life analysis.

86-555

Vibrations of Railroad Tracks Subject to Oscillating and Moving Loads

S.P. Patil

Ph.D. Thesis, Univ. of Delaware, 173 pp (1984), DA8511226

KEY WORDS: Railroad tracks, Moving loads

The effect of an unsprung mass of a vibrating load on the dynamic response of a railroad track, is determined. To simplify the analysis the track is modeled as a beam on the Winkler foundation. A dynamic analysis, without assuming a priori, a steady state solution, is carried out in order to establish the effect of this assumption. This procedure demonstrates the significant effect, of even a small amount of load mass, on the dynamic response of the beam resting on the Winkler foundation.

POWER PLANTS

86-556

Fluid-Structure Vibration Analysis Using Structural Finite Element Computer Codes

R.E. Schwirian, R.A. Riddell, N.R. Singleton, D.F. DeSanto

Westinghouse Electric Corp., Pittsburgh, PA

Flow-Induced Vibrations Symp., Vol. 6, Computational Aspects of Flow Induced Vibration, ASME Winter Annual mtg., New Orleans, LA, Dec 9-14, 1984, pp 1-16, 15 figs, 6 tables, 11 refs

KEY WORDS: Nuclear reactor components, Fluid-structure interaction, Fluid-induced excitation

Techniques are presented for using elements and constraint/coupling conditions available in many structural analysis finite element computer codes, to represent compressible or incompressible fluids and the proper solid-fluid interface conditions in a realistic manner. Methods are described for using nodal force loading and nodal displacement constraint options to simulate flow induced vibration mechanisms such as pump induced pulsations, turbulence and vortex shedding.

86-557

Analysis of Seismic Sloshing of Reactor Tanks Considering Submerged Components and Seismic Isolation

D.C. Ma, Y.M. Chang

Argonne National Lab., Argonne, IL

Rept. No. CONF-850670-14, 10 pp (1985), DE85010499/GAR

KEY WORDS: Nuclear reactors, Sloshing, Fluid-structure interaction, Seismic isolation

A study of the seismic sloshing response of a large pool-type reactor tank with several deck-mounted components is presented. The main objective of the study is to investigate the effects of internal components on the sloshing response and to determine the sloshing loads on the components.

OFF-SHORE STRUCTURES

86-558

A Finite Element Method for the Statistics of Non-Linear Random Vibration

R.S. Langley

Cranfield Inst. of Technology, Cranfield, Bedford MK43 OAL, UK

J. Sound Vib., 101 (1), pp 41-54 (July 8, 1985), 8 figs, 17 refs

KEY WORDS: Off-shore structures, Fatigue life, Finite element technique, Probability density function, Statistical analysis

The transitional probability density function for the random response of a certain class of nonlinear system satisfies the Fokker-Planck-Kolmogorov equation. This paper concerns the numerical solution of the stationary form of this equation, yielding the stationary probability density function of response. The weighted residual statement for the problem is integrated by parts to yield the weak form of the equations, which are then solved by the finite element method. The method is applied to a Duffing oscillator and good agreement is found with the exact result.

86-559
Offshore Platform Fatigue Cracking Probability
A.E. Knapp, B. Stahl
Amoco Production, Tulsa, OK
ASCE J. Struc. Engrg., 111 (8), pp 1647-1660 (Aug 1985), 3 figs, 10 tables, 12 refs

KEY WORDS: Off-shore structures, Drilling platforms, Fatigue life

A systems approach is presented for fatigue reliability analysis of offshore platforms. The probability of fatigue crack occurrence in individual structural joints is considered. A nomograph relating deterministic fatigue life to probability of fatigue cracking is developed based on the lognormal fatigue reliability format. The effects of fatigue life correlation are included. Analysis of a North Sea platform indicates a high level of reliability against fatigue damage.

86-560
Soil-Structure Interaction and Effect of Axial Force on the Dynamics of Offshore Structures
B.A. Ovunc
Univ. of Southwestern Louisiana, Lafayette, LA
Computers Struc., 21 (4), pp 629-637 (1985), 13 figs, 18 refs

KEY WORDS: Off-shore structures, Soil-structure interaction, Computer programs

Offshore structures are flexible systems subjected to various types of loadings. Under vibration variation in the pore pressures induces additional effects on the embedded part of the piles. The effect of the soil-structure interaction on the dynamics of the structure is taken into account as the deformations of the soil caused by the motion of the structure modify the response of the structure. The effect of the axial forces, within the individual members, on the vibration of the structure is included in the formulation. The new formulation is introduced in the general purpose computer code STDYNL, and the sensitivity of the overall dynamic response of the deep water platforms to the variation of the soil characteristics and to the effect of the axial forces of the members are investigated.

86-561
Behavior of Prestressed Concrete Subjected to Low Temperatures and Cyclic Loading
D.E. Berner
Ph.D. Thesis, Univ. of California, 222 pp (1984), DA8512756

KEY WORDS: Off-shore structures, Containment structures, Prestressed concrete, Cryogenic systems, Cyclic loading

Concrete has exhibited excellent behavior in cryogenic containment vessels for several decades under essentially static conditions. Tests were conducted to determine the response of prestressed lightweight concrete subjected to high-intensity cyclic loading and simultaneous cryogenic thermal shock, simulating the relatively dynamic conditions encountered offshore or in seismic areas.

86-562
Recent Advances in High-Frequency Wave Forces on Fixed Structures
S.K. Chakrabarti
CBI Industries, Inc., Plainfield, IL 60544
J. Energy Resources Tech., Trans. ASME, 107 (3), pp 315-328 (Sept 1985), 21 figs, 54 refs

KEY WORDS: Off-shore structures, Wave forces

Many analytical tools are available for the determination of wave effects on offshore structures. These methods may be divided into two major categories: one for small members of an offshore structure and one for large members. A hybrid method is used for structures that have both types of members. The advances made in the last few years in the specific area of computing the high-frequency forces are reviewed here.

86-563
Collisions and Damage of Offshore Structures: A State-of-the-Art
C.P. Ellinas, S. Valsgard
J.P. Kenny & Partners Ltd., London, UK
J. Energy Resources Tech., Trans. ASME, 107 (3), pp 297-314 (Sept 1985), 16 figs, 3 tables, 139 refs

KEY WORDS: Off-shore structures, Collision research (ships)

Over the recent years, following the very rapid increase in the construction and installation of offshore structures, there has been a considerable growth of interest in the assessment of the probabilities and consequences of collision and damage of such structures. This paper reviews the state-of-the-art with respect to the probabilities and consequences of collisions and accidental loading in general, and methods for the assessment of the design of steel offshore structures against damage. Emphasis is placed on research activity and available information concerned with offshore structures, such as platforms, semisubmersibles, etc.

VEHICLE SYSTEMS

GROUND VEHICLES

86-564
Nonlinear Oscillations of a Simple Flexible Skirt Air Cushion
P.A. Sullivan, J.E. Byrne, M.J. Hinchey
Univ. of Toronto, Downsview, Ontario, Canada
J. Sound Vib., 102 (2), pp 269-283 (Sept 22, 1985), 15 figs, 26 refs

KEY WORDS: Surface effect machines, Oscillation

Intrinsically nonlinear aspects of the heavy dynamics of a flexible skirted plenum chamber air cushion are investigated analytically and experimentally. The phenomenon used for this purpose is the tendency of dynamically unstable cushion motion to grow to a stable limit cycle oscillation. Two nonlinearities are included in the mathematical model: the quasi-steady orifice law applied to the cushion air escape and other flow processes, and flow shut-off associated with skirt-ground contact. Numerical procedures are applied to the differential equations to predict frequencies, amplitudes and waveforms of the oscillations.

SHIPS

86-565
Dynamic Response of a Wingsail Mast to Unsteady Aerodynamic Loads Including Ship Motion Effects
G.J. Firestein
Ph.D. Thesis, Univ. of California, Berkeley, 237 pp (1984), DA8512816

KEY WORDS: Ships, Wind-induced excitation, Computer programs

Development of an analytical procedure to calculate the dynamic response of a wingsail mast is discussed. The loads consist of unsteady aerodynamic forces on the wingsail and inertial loads due to motion of the ship. A FORTRAN-80 program for microcomputers is developed to automate the procedure.

86-566
Static/Dynamic Redesign of Marine Structures
C.J. Hoff
Ph.D. Thesis, Univ. of Michigan, 127 pp (1985), DA8512429

KEY WORDS: Ships, Structural modification techniques

A finite element analysis can accurately predict the static and dynamic response of a large marine structure. In many instances the response characteristics are undesirable and structural redesign is required. Current methods to solve the redesign problem are based on trial and error approaches which are expensive in terms of computer and manpower resources. A method is developed to solve the static redesign problem to achieve large displacement and stress changes. Perturbation of the static equilibrium equation is used to develop an equation governing the static redesign. This equation is solved using an iterative technique which is efficient since the inverse (or Cholesky decomposition) of the stiffness matrix is not required.

86-567

Tone Excited Jets, Part I: Introduction

H.K. Tanna, K.K. Ahuja

Lockheed-Georgia Co., Marietta, GA

J. Sound Vib., 102 (1), pp 57-61 (Sept 1985), 14 refs

KEY WORDS: Aircraft noise, Jet noise

An overview of the problem of broadband amplification of jet noise by upstream discrete tone excitation is presented.

86-568

Tone Excited Jets, Part II: Flow Visualization

K.K. Ahuja, M.C. Whiffen

Lockheed-Georgia Co., Marietta, GA

J. Sound Vib., 102 (1), pp 63-69 (Sept 1985), 10 figs, 5 refs

KEY WORDS: Aircraft noise, Jet noise, Photographic techniques

Schlieren photographs of tone excited jets obtained by an ensemble averaging method are presented. The method consisted of phase locking the large-scale turbulence structures and multiple exposure of a given photographic film, and made it possible to photographically separate out the large-scale turbulence structures from the small-scale random turbulence

86-569

Tone Excited Jets, Part III: Flow Measurements

J. Lepicovsky, K.K. Ahuja, R.H. Burrin

Lockheed-Georgia Co., Marietta, GA

J. Sound Vib., 102 (1), pp 71-91 (Sept 1985), 19 figs, 10 refs

KEY WORDS: Aircraft noise, Jet noise, Flow measurement

The effects of upstream excitation on the flow characteristics of a jet under static as well as simulated forward velocity conditions are described. The data presented include axial and radial distributions of mean velocities and turbulence intensities as functions of excitation conditions. Results for both unheated and heated jets are presented.

86-570

Tone Excited Jets, Part IV: Acoustic Measurements

K.K. Ahuja, D.F. Blakney

Lockheed-Georgia Co., Marietta, GA

J. Sound Vib., 102 (1), pp 93-117 (Sept 1985), 27 figs, 13 refs

KEY WORDS: Aircraft noise, Jet noise, Experimental data

The acoustic results from a well-controlled experiment designed to obtain an understanding of the noise generated by a tone-excited jet are described, with particular emphasis on the mechanism of broadband jet-noise amplification. Results for a 5.05-cm-diameter nozzle are presented for both unheated and heated jets, with and without the effect of forward flight simulation for a range of excitation frequencies and levels, and for two mode orders: the zero-order and the first-order spinning mode.

86-571

Tone Excited Jets, Part V: A Theoretical Model and Comparison with Experiment

C.K.W. Tam, P.J. Morris

Florida State Univ., Tallahassee, FL

J. Sound Vib., 102 (1), pp 119-151 (Sept 1985) 20 figs, 25 refs

KEY WORDS: Aircraft noise, Jet noise, Mathematical models

A mathematical model of tone-excited jets is developed. The model consists of two major components. The first component involves a mathematical description of the process by which the intrinsic instability waves of the jet are excited by upstream tones. This process is generally referred to as receptivity. The second component is the modeling of the nonlinear interaction between the mean flow of the jet, the excited large-scale instability waves or turbulence structure and the fine-scale turbulence.

86-572

Lateral Attenuation of Aircraft Flight Noise

D.E. Bishop

BBN Labs., Inc., Canoga Park, CA

Rept. No. BBN-5668, AFAMRL-TR-85-18, 34 pp (Mar 1985), AD-A154 958/3/GAR

KEY WORDS: Aircraft noise, Noise reduction

This report reviews models for calculating the lateral attenuation of aircraft flight noise, in particular, the change in attenuation for different elevation angles varying from aircraft directly overhead, (90 deg. elevation angle) to a zero elevation angle. Sets of noise spectrum-dependent lateral attenuation values derived from theory and from experimental flight measurements were applied to sets of different aircraft noise spectra to determine A-level differences with elevation angle.

86-573
Noise Transmission into Propeller Aircraft
R. Vaicaitis
Columbia Univ., New York, NY
Shock Vib. Dig., 17 (8), pp 15-20 (Aug 1985), 63 refs

KEY WORDS: Aircraft noise, Interior noise, Structure borne noise, Reviews

This paper is a survey of papers and reports, most of which were written since 1981, that are concerned with airborne and structure-borne noise transmission into a propeller-driven aircraft. Special attention is given to a new propfan aircraft.

86-574
Fundamental Studies of Structure Borne Noise for Advanced Turboprop Applications
W. Eversman, L.R. Koval
Univ. of Missouri, Rolla, MO
Rept. No. NASA-CR-175737, 14 pp (May 1985), N85-26320/0/GAR

KEY WORDS: Aircraft noise, Interior noise, Structure borne noise, Engine vibration

The transmission of sound generated by wing-mounted, advanced turboprop engines into the cabin interior via structural paths is considered. The structural model employed is a beam representation of the wing box carried into the fuselage via a representative frame type of carry through structure. The structure for the cabin cavity is a stiffened shell of rectangular or cylindrical geometry. The structure is modeled using a finite element formulation and the acoustic cavity is modeled using an analytical representation appropriate for the geometry. The mathematical model for the interior noise problem is demonstrated with a simple plate/cavity system which has all of the features of the fuselage interior noise problem.

86-575
Transmission of Gear Noise to Aircraft Interiors Prediction Methods
A. Berman
Kaman Aerospace Corp., Bloomfield, CT
Gears and Power Transm. Systems for Helicopters and Turboprops; Conf. Proc., Lisbon, Portugal, Oct 8-12, 1984, pp 27-1 - 27-7 (AD-A152 673), AD-P004 671/4/GAR

KEY WORDS: Helicopter noise, Aircraft noise, Interior noise, Gear-induced vibration, Computer programs

Prediction of interior noise of helicopters due to drive train vibration ideally requires an analytical model of the entire dynamic system including airframe, transmission, and all attachments. This paper addresses the need for such a model and certain of the critical issues involved: the inadequacy of finite element modeling in the acoustic frequency range; the costs associated with assessment of parametric variations; the costs associated with assessment of parametric variations; and the difficulty of incorporating new technology into existing computer programs. Potential solutions to these problems are included.

86-576
Identification of Gust Input and Gust Response Characteristics from Do 28 TNT Flight Test Data
D. Rohlf
Deutsche Forschungs- und Versuchsanstalt fuer Luft- und Raumfahrt e.V., Brunswick, Fed. Rep. Germany
Rept. No. DFVLR-FB-84-48, ESA-TT-919, 59 pp (Nov 1984), N85-27881/0/GAR

KEY WORDS: Aircraft, Wind-induced excitation

A method to determine gust response characteristics and simultaneously estimate the discrete gust input from flight test data using system identification techniques is presented. The method is restricted to longitudinal motion of aircraft with separated wing and tail surfaces at low Mach numbers.

86-577
Inlet Flow Dynamic Distortion Prediction — Without RMS Measurements
Yen-Sen Chen
Ph.D. Thesis, Univ. of Kansas, 118 pp (1984), DA8513816

KEY WORDS: Aircraft, Turbulence, Finite difference technique

A two-equation turbulence model is used in the prediction of inlet flow dynamic distortion of jet aircraft based on steady state total pressure measurements only. This turbulence model is solved at the compressor face station by using a finite difference scheme. Total pressure rms level of the inlet flow is predicted by the turbulence model. The Melick statistical method is then employed to estimate the peak dynamic distortion based on the analytically predicted total pressure rms level.

86-578
Design of a Digital Ride Quality Augmentation System for Commuter Aircraft
T.A. Hammond
Ph.D. Thesis, Univ. of Kansas, 378 pp (1984), DA8513812

KEY WORDS: Aircraft, Aerodynamic loads, Turbulence

This project was initiated based on the goal of making the ride of the commuter aircraft as smooth as the ride experienced on the major commercial airliners. The objectives of the project were to design a digital, longitudinal mode ride quality augmentation system for a commuter aircraft, and to investigate the effect of selected parameters on those designs.

86-579
Optimization of Airplane Wing Structures Under Gust Loads
S.S. Rao
San Diego State Univ., San Diego, CA
Computers Struc., 21 (4), pp 741-749 (1985), 9 figs, 4 tables, 12 refs

KEY WORDS: Aircraft wings, Wind-induced excitation, Optimum design

A methodology is presented for the optimum design of aircraft wing structures subjected to gust loads. The equations of motion, in the form of coupled integro-differential equations, are solved numerically and the stresses in the aircraft wing structure are found for a discrete gust encounter. A sensitivity analysis is conducted to find the effects of changes in design variables about the optimum point on the response quantities of the wing structure.

MISSILES AND SPACECRAFT

86-580
Acoustic Radiation Damping
B.L. Clarkson, K.T. Brown
Univ. College of Swansea, Swansea, UK
J. Vib., Acoust., Stress Rel. Des., Trans. ASME, 107 (4), pp 357-360 (Oct 1985), 6 figs, 9 refs

KEY WORDS: Spacecraft platforms, Honeycomb structures, Acoustic absorption, Experimental data

Experimental results of an investigation of acoustic radiation damping of a honeycomb spacecraft platform are presented. The measurements were made on the honeycomb center platform of the OTS satellite structure and compared to measurements on a uniform aluminum plate.

BIOLOGICAL SYSTEMS

HUMAN

86-581
Contribution of Tonal Components to the Overall Loudness, Annoyance and Noisiness of Noise: Relation Between Single Tones and Noise Spectral Shape
R.P. Hellman
Sargent College of Allied Health Professions, Boston, MA
Rept. No. NASA-CR-3892, 148 pp (May 1985), N85-26317/6/GAR

KEY WORDS: Noise tolerance, Human response

A large scale laboratory investigation of loudness, annoyance, and noisiness produced by sin gle-tone-noise complexes was undertaken, to establish a broader data base for quantification and prediction of perceived annoyance of sounds containing tonal components. Loudness, annoyance, and noisiness were distinguished as separate, distinct, attributes of sound. Three different spectral patterns of broadband noise with and without added tones were studied: broadband-flat, low-pass, and high-pass.

86-582
Study of the Methods for Evaluating the Noise Impact of a Proposed Airport on a Community
P.J. Griffiths
New South Wales Univ., Kensington, Australia
3 pp (1984), N85-25957/0/GAR

KEY WORDS: Aircraft noise, Airports, Human response

Six different methods of evaluating the noise impact of a proposed airport are compared. This comparison is made in terms of land use plans based on aircraft noise exposure. Land use plans are developed from community levels of annoyance correlated with some method of describing the noise exposure. The general principles and assumptions used in developing aircraft noise rating procedures are discussed.

86-583
Floor Vibrations and Human Discomfort
S. Ohlsson
Chalmers Univ. of Technology, Goteborg, Sweden
J. Sound Vib., 100 (4), 276 pp (June 22, 1985), 163 figs, 20 tables, 65 refs

KEY WORDS: Human response, Floors, Vibration control

Experimental investigations of the dynamic response of different lightweight floors are presented. Both laboratory and field tests are included. Different methods for improving the response are suggested. Methods for adding damping to a floor are given as well as an alternate design to cross-bridging for timber floors.

86-584
The Generation and Perception of Vibration from Rail Traffic
M.J. Griffin, C.G. Stanworth
Track Technology for the Next Decade, Conf., Proc. Inst. of Civil Engrs., Univ. of Nottingham, July 11-13, 1984

KEY WORDS: Human response, Buildings, Railroad trains, Traffic-induced vibrations

Wayside vibrations caused by trains on main line railways are investigated both in field and laboratory studies. Initial results suggest a measure of vibration does which seems to correlate well with subjective responses to railway vibrations imposed in a laboratory. The frequency weighting and the form of integration in the dose, when combined with features of the generation process revealed experimentally, suggest the extent and form of remedial measures.

MECHANICAL COMPONENTS

ABSORBERS AND ISOLATORS

86-585
Absorption Properties of Baffles for Noise Control in Industrial Halls
A. Cops
Katholieke Universiteit Leuven, Celestijnenlaan 200D, B-3030 Leuven, Belgium
Appl. Acoust., 18 (6), pp 435-448 (1985), 14 figs, 7 refs

KEY WORDS: Baffles, Acoustic absorption, Industrial facilities, Noise reduction

As a consequence of the growing number of industrial plants in existence, an increasing number of people working in industrial halls encounter problems caused by noise nuisance. Baffles are the absorbing acoustic materials which are generally used. In order to assure optimal sound absorption, laboratory tests and measurements were carried out on flat and cylindrical suspended baffles.

86-586
Suspension Optimization of a 2-DOF Vehicle Model Using a Stochastic Optimal Control Technique
A. Hać

Technical Univ. of Warsaw, Poland
J. Sound Vib., 100 (3), pp 343-357 (June 8, 1985), 6 figs, 9 refs

KEY WORDS: Suspension systems (vehicles), Optimum control theory, Two degree of freedom systems, Active vibration control, Stochastic processes

The problem of active suspension control of a two-degree-of-freedom vehicle traveling on a randomly profiled road is studied. The suspension system is optimized with respect to ride comfort, road holding and working space of the suspension. Stochastic optimal linear control theory is used in solving the problem. The optimal value of the control variable is calculated. The average behavior of an optimally controlled system is calculated and compared to that of an optimal passive system.

86-587
Aseismic Base Isolation
J.M. Kelly
Univ. of California, Berkeley, CA
Shock Vib. Dig., 17 (7), pp 3-14 (July 1985), 74 refs

KEY WORDS: Buildings, Base isolation, Seismic isolation, Reviews

This review covers developments in research and implementation in aseismic base isolation since May, 1981. The considerable increase in research has been both theoretical and experimental and has been conducted at an increasing number of centers. There has been a concomitant increase in the implementation of technology. Several new buildings have utilized various forms of base isolation system. This review describes these recent developments.

86-588
A Study of Active Vibration Isolation
N. Tanaka, Y. Kikushima
Mechanical Engrg. Lab., Ibarakiken 305, Japan
J. Vib., Acoust., Stress Rel. Des., Trans. ASCE, 107 (4), pp 392-397 (Oct 1985), 14 figs, 2 tables, 5 refs

KEY WORDS: Vibration isolation, Active vibration control, Ground vibration, Machinery-induced vibrations

For the purpose of suppressing ground vibration produced by vibrating machines, such as forging hammers, press machines, etc., this paper presents an active vibration isolation method. Unlike conventional isolators, the active isolator proposed permits rigid support of the machines. The principle of the active isolation method is shown, and the system equations are derived. Characteristics and design parameters of the active isolation system are presented.

86-589
Shock Response of a Symmetric Pneumatic Spring to a Velocity Pulse
M.S. Hundal
Univ. of Vermont, Burlington, VT
J. Sound Vib., 101 (1), pp 33-40 (July 8, 1985), 4 figs, 12 refs

KEY WORDS: Shock isolators, Pneumatic isolators, Pneumatic springs

Modeling and response of a pneumatic shock isolator are presented. The isolator is a symmetric pneumatic spring with self-damping, subject to a velocity pulse. Parametric studies show the effect of non-dimensional parameters on system response. The analysis of response of an undamped spring is also given.

TIRES AND WHEELS

86-590
Relationship of Truck Tire/Wheel Nonuniformities to Cyclic Force Generation
T.D. Gillespie
Univ. of Michigan, Ann Arbor, MI
Rept. No. UMTRI-84-18, 139 pp (Apr 1984), PB85-184406/GAR

KEY WORDS: Truck tires, Tire-wheel interaction

Nonuniformities in the tire/wheel assemblies of heavy trucks, such as mass imbalance or dimensional runout, add to the ride vibrations on the road at the rotational frequency of the wheel and harmonics thereof. The relationships between nonuniformities in the individual components and the excitation forces produced by the overall assembly are largely unknown. An experimental research program was conducted in which nonuniformities in tire and wheel components and the force variations of the overall assembly were measured on a tire uniformity test machine.

BLADES

86-591
Vibration and Buckling of Rotating, Pretwisted, Preconed Beams Including Coriolis Effects
K.B. Subrahmanyam, K.R.V. Kaza
NASA Lewis Res. Ctr., Cleveland, OH
Rept. No. E-2310, NASA-TM-87004, 21 pp (1985)
N85-25893/7/GAR

KEY WORDS: Cantilever beams, Blades, Geometric effects, Coriolis forces, Natural frequencies

The effects of pretwist, precone, setting angle and Coriolis forces on the vibration and buckling behavior of rotating, torsionally rigid, cantilevered beams were studied. The beam is considered to be clamped on the axis of rotation in one case, and off the axis of rotation in the other. Two methods are employed for the solution of the vibration problem.

86-592
Investigation of the Structural Behavior of the Blades of a Darrieus Wind Turbine
A. Rosen, H. Abramovich
Technion-Israel Inst. of Technology, Haifa, Israel
J. Sound Vib., 100 (4), pp 493-509 (June 22, 1985) 7 figs, 20 refs

KEY WORDS: Turbine blades

A theoretical model in which account is taken of the nonlinear, non-planar structural behavior of the curved blades of a Darrieus wind turbine is described. This model is simpler and needs less computational effort than some other models, but is still accurate enough for most engineering purposes. By using the present method, it is possible to treat any blade geometry, any structural, mass and aerodynamic blade properties distribution and any combination of boundary conditions.

BEARINGS

86-593
On the Use of Rotor-Bearing Instability Thresholds to Accurately Measure Bearing Rotordynamic Properties
M.L. Adams, M. Rashidi
J. Vib., Acoust., Stress Rel. Des., Trans. ASME, 107 (4), pp 404-409 (Oct 1985) 4 figs, 4 tables, 15 refs

KEY WORDS: Journal bearings, Stability, Stiffness coefficients, Damping coefficients

A re-examination of rotor-bearing instability has led to a fresh approach that can potentially improve measurement accuracy of journal bearing rotordynamic coefficients. The approach uses a two-degree-of-freedom system and has three major parts. The fundamental advantages of the overall approach stem from the physical requirement for an exact internal energy balance between positive and negative damping influences at an instability threshold, and that it does not require the measurement of dynamic forces.

86-594
The Vibrations of Radial Ball Bearings
H. Rahnejat, R. Gohar
Imperial College of Science and Technology, London, UK
IMechE, Proc., 199 (C3), pp 181-193 (1985) 15 figs, 17 refs

KEY WORDS: Ball bearings

A theoretical analysis of the vibration response of a rotating rigid shaft supported by two radial deep-groove lubricated ball bearings is presented. The bearings and their oil films are approximated to a set of nonlinear elastic springs and dampers rotating relative to the shaft when it is subjected to a rotating unbalance or inner race surface waviness. Rotating unbalance and surface features introduce further significant frequencies which influence the output response.

86-595
The Performance of a Sealed Squeeze-Film Bearing in a Flexible Support Structure
R. Holmes, M. Dogan
Univ. of Southampton, UK

IMechE, Proc., 199 (C1), pp 1-9 (1985) 8 figs, 5 refs

KEY WORDS: Squeeze-film bearings, Damping coefficients

Attention is given to empirically modeling the hydrodynamics of a tightly sealed squeeze-film bearing in a flexible support structure simulating an aero-engine assembly, with a view to assessing its damping performance. It is found that predictable experimental results are obtained by employing an end-leakage factor which relates the outlet pressure around the bearing circumference to the corresponding long-bearing pressure.

BELTS

86-596
Vibration Coupling in Continuous Belt and Band Systems
C.D. Mote, Jr., W.Z. Wu
Univ. of California, Berkeley, CA
J. Sound Vib., 102 (1), pp 1-9 (Sept 1985) 9 figs, 12 refs

KEY WORDS: Band saws, Belts (moving), Flexural vibrations

Small transverse oscillation of an endless band supported by wheels couples the response of the free spans of the band to oscillation of the wheels. The coupling arises from the finite curvature of the free spans of the band when its bending stiffness is finite. Significant modeling error can occur if a single span of the band is modeled as a simply supported, axially moving beam. The coupling provides an opportunity to dissipate vibration energy.

GEARS

86-597
Gear Noise Origins
W.D. Mark
Bolt Beranek and Newman, Inc., Cambridge, MA
Gears and Power Transm. Systems for Helicopters and Turboprops, Conf. Proc., Lisbon, Portugal, Oct 8-12, 1984, pp 30-1 - 30-14 (AD-A152 673), AD-P004 674/8/GAR

KEY WORDS: Gears, Noise generation

Each pair of meshing gears in a transmission gives rise to a source of vibratory excitation that can result in the radiation of sound. Each such source is most conveniently characterized as a displacement form of excitation generally referred to as the static transmission error of the gear pair. Contributions to the frequency spectrum of the static transmission error of spur and helical gears arising from tooth and gear body elastic deformations and from deviations of tooth surfaces from perfect involute surfaces are considered.

86-598
The Derivation of Gear Transmission Error from Pitch Error Records
H. Kohler, R. Regan
Univ. of Sheffield, UK
IMechE, Proc., 199 (C3), pp 195-201 (1985) 11 figs, 8 refs

KEY WORDS: Gears, Error analysis

The effect of pitch errors on the transmission error of a gear pair is examined. It has been thought that, if pitch error alone is present, the frequency spectrum of the corresponding transmission error will have no components either at the tooth contact frequency or any of its harmonics. It is shown that, in general, tooth contact harmonics of significant amplitudes will exist.

86-599
Multi-Mesh Gear Dynamics Program Evaluation and Enhancements
L.S. Boyd, J. Pike
Hamilton Standard, Windsor Locks, CT
Rept. No. NASA-CR-174747, 128 pp (May 1985) N85-28372/9/GAR

KEY WORDS: Gears, Computer programs

A multiple mesh gear dynamics computer program was continually developed and modified during the last four years. The program can handle epicyclic gear systems as well as single mesh systems with internal, buttress, or helical tooth forms. The following modifications were added: variable contact friction, planet cage and ring gear rim flexibility options, user friendly options, dynamic side bands, a speed survey option and the combining of the single and multiple mesh options into one general program. The modified program was evaluated by comparing calculated values to published test data and to test data taken on a turboprop reduction gear-box.

86-600
An Explanation for the Asymmetry of the Modulation Sidebands about the Tooth Meshing Frequency in Epicyclic Gear Vibration
P.D. McFadden, J.D. Smith
Aeronautical Research Labs., Melbourne, Victoria, Australia
IMechE, Proc., 199 (C1), pp 65-70 (1985) 6 figs, 7 refs

KEY WORDS: Planet gears

The vibration spectra of epicyclic gears commonly exhibit considerable asymmetry of the modulation sidebands and even complete suppression of the component at the tooth meshing frequency. A model is proposed which explains these observations in terms of the relationship between the vibrations generated by each of the planet gears as they move relative to the transducer location.

COUPLINGS

86-601
The Measurement of Loads Occurring in a Fifth Wheel Coupling of an Articulated Vehicle
B.G. Bevan, N.F. Barter
The Motor Industry Research Assn., Warwickshire, UK
Rept. No. KP34, 26 pp, 2 figs, 18 tables, 1 ref

KEY WORDS: Fifth wheel couplings, Articulated vehicles, Experimental data

This is a report on a program to obtain fundamental data on loads occurring in fifth wheel couplings under a variety of operating conditions. This data is required to form the basis for a proposed test procedure for the testing of coupling devices. Two fifth wheels were used: one was conventional with rubber shock mounts incorporated and the other, similar but with metal mounts.

FASTENERS

86-602
Fatigue Behavior of HY-130 Steel Weldments Containing Fabrication Discontinuities
S.J. Gill, J.A. Hauser, T.W. Crooker, B.J. Kruse
Naval Res. Lab., Washington, DC
Rept. No. NRL-MR-5520, 39 pp (Apr 18, 1985)
AD-A153 630/9/GAR

KEY WORDS: Welded joints, Fatigue life, Cyclic loading, Discontinuity-containing media

This study was undertaken to explore the applicability of linear elastic fracture mechanics to characterize the fatigue behavior of high-strength steel weldments containing lack-of-penetration and slag/lack-of-profusion discontinuities. Full penetration, double-V butt welds with reinforcements removed were tested under zero-to-tension axial loading. Various filler metals and welding techniques were used. Both sound welds and welds containing discontinuities were cycled to failure.

86-603
Cyclic Out-of-Plane Buckling of Double-Angle Bracing
A. Astaneh-Asl, S.C. Goel, R.D. Hanson
Univ. of Oklahoma, Norman, OK
ASCE J. Struc. Engrg., 111 (5), pp 1135-1153 (May 1985) 21 figs, 15 refs

KEY WORDS: Braces, Dynamic buckling, Cyclic loading

The behavior of double-angle bracing members subjected to out-of-plane buckling due to severe cyclic load reversals is investigated. Nine full-size test specimens were subjected to severe inelastic axial deformations. Test specimens were made of back-to-back A36 steel angle sections connected to the end gusset plates by fillet welds or high-strength bolts.

STRUCTURAL COMPONENTS

CABLES

86-604
Flexural Rigidity of Stranded Cables

T.V. Gopalan, G.R. Nagabhushana
Indian Inst. of Science, Bangalore, India
Shock Vib. Dig., 17 (6), pp 17-20 (June 1985) 3 figs, 10 refs

KEY WORDS: Cables, Transmission lines, Flexural stiffness, Reviews

Flexural rigidity and maximum fiber distance are important in the dynamics of the multi-stranded cables used in overhead power lines. This paper discusses a satisfactory solution based on experimental results for obtaining these parameters.

BARS AND RODS

86-605
Continuum Transfer Matrix for a Rod Element with Continuous External Damping
D.C. Ohanehi, L.D. Mitchell
Kollmorgen Corp., Radford, VA
Flow-Induced Vibrations Symp., Vol. 6, Computational Aspects of Flow-Induced Vibration, ASME Winter Annual Mtg., New Orleans, LA, Dec 9-14, 1984, pp 69-79, 7 figs, 18 refs

KEY WORDS: Rods, Viscous damping, Drills

The continuum mechanics transfer matrix formulation for the steady-state vibration of an axial, hollow, structurally damped rod fully submerged in a viscous fluid is developed. The solution automatically includes the effect of the attached viscously coupled fluid mass as well as the external and internal viscous drag. The transfer matrix solution is used to solve an oil well drilling dynamics problem.

86-606
Longitudinal Vibrations of Pre-Twisted Bars with "Asymmetric" Boundary Conditions
G. Curti, A. Risitano
Politecnico di Torino, Italy
Meccanica, 20 (2), pp 160-163 (June 1985) 1 fig, 2 tables, 14 refs

KEY WORDS: Bars, Longitudinal vibrations, Boundary condition effects

Concerning the determination of angular frequencies of a twisted straight bar of constant section, seven possible (asymmetric) constraint conditions are considered and the corresponding frequency equations are found. A final numerical example with several increasing twisting degrees shows the different influence of this increase upon the frequencies having axial or torsional origin.

86-607
On the Free Motions of a Uniform Elastic Helicoidal Bar
D.E. Panayotounakos
National Technical Univ. of Athens, Athens, Greece
Meccanica, 20 (2), pp 151-159 (June 1985) 15 refs

KEY WORDS: Bars, Natural frequencies

A thorough and rigorous analysis for the decoupling of a first-order partial differential system of four (3x1)-vectorial equations (with constant coefficients), governing the free three-dimensional dynamic equilibrium of an arc element of an elastic circular helicoidal bar, is presented. As an application on the method and under some restrictions the general integral of the differential equation of harmonic motions of an elastic helicoidal bar is determined in the form of elementary functions.

86-608
Effect of Rotatory Inertia and Shear Deformation on Vibration of an Inclined Bar with an End Constraint
C.H. Chang, Y.C. Juan
Univ. of Alabama, University, AL
J. Sound Vib., 101 (2), pp 171-180 (July 22, 1985) 5 figs, 2 tables, 12 refs

KEY WORDS: Bars, Rotatory inertia effects, Transverse shear deformation effects

A set of equations for the free vibration of an inclined bar with an end constraint including the effect of rotatory inertia and shear deformation is derived by the variational method. The equations for the axial and transverse vibrations are coupled by the end constraint. Exact solutions for the linearized equations are obtained. The effect of rotatory inertia without and with shear deformation is examined.

86-609
Impact Effect on R.C. Slabs: Analytical Approach

M. Abdel-Rohman, J. Sawan
Kuwait Univ., Kuwait
ASCE J. Struc. Engrg., 111 (7), pp 1590-1601 (July 1985) 5 figs, 3 tables, 8 refs

KEY WORDS: Slabs, Reinforced concrete, Impact response

Three simple analytical methods to study the impact effect on R.C. slabs are presented. These methods are the impact factor, the equivalent mass method, and the continuous mass method. Several aspects that affect the slab's response due to impact are investigated. Results from these methods are compared with similar experimental ones.

BEAMS

86-610
The Behavior of a Linear, Damped Modal System with a Non-Linear Spring-Mass-Dry Friction Damper System Attached, Part II
A.A. Ferri, E.H. Dowell
Duke Univ., Durham, NC
J. Sound Vib., 101 (1), pp 55-74 (July 8, 1985) 14 figs, 7 refs

KEY WORDS: Beams, Viscous damping, Modal damping, Component mode analysis, Harmonic balance method

In a previous article the behavior of a combined system consisting of a linear simply supported beam with viscous modal damping connected to a spring-mass - dry friction damper system was analyzed by using component mode analysis and first-order harmonic balance. Unfortunately, a sign error in the harmonic balance analysis must be pointed out. The purpose of this paper is to correct the previous error, to re-examine the results of the previous paper, and to present some further work.

86-611
The Stability of Timoshenko Beams Conveying a Compressible Fluid
R.O. Johnson
Ph.D. Thesis, Univ. of Tennessee, 175 pp (1984), DA8506899

KEY WORDS: Beams, Timoshenko theory, Damping effects, Tubes, Fluid-filled containers

The purpose of this study is to formulate and solve the stability problem associated with the equations of motion of a Timoshenko beam conveying a compressible fluid. The beam is assumed to be either cantilevered or simply supported. Shear deformation and rotary inertia are considered in the Timoshenko beam theory. The beam analysis that is carried out is quite general and allows for viscous damping external to the tube as well as both internal strain rate and hysteretic damping. Interactions between these three damping mechanisms, shear deformation, and rotary inertia also are accounted for.

86-612
On the Shear Deformation Theory for Dynamic Analysis of Beams
A.V. Krishna Murty
Indian Inst. of Science, Bangalore, India
J. Sound Vib., 101 (1), pp 1-12 (July 8, 1985) 5 figs, 8 tables, 10 refs

KEY WORDS: Beams, Timoshenko theory, Transverse shear deformation effects, Mode shapes

Timoshenko's shear deformation theory is widely used for the dynamical analysis of shear-flexible beams. A comparative study of the shear deformation theory with a higher order model, of which Timoshenko's shear deformation model is a special case, is presented.

86-613
Impulsive Direct Shear Failure in RC Slabs
T.J. Ross, H. Krawinkler
Air Force Weapons Lab., Albuquerque, NM
ASCE J. Struc. Engrg., 111 (8), pp 1661-1667 (Aug 1985) 11 figs, 1 table, 14 refs

KEY WORDS: Beams, Slabs, Reinforced concrete, Shear strength, Timoshenko theory

The research summarized in this paper makes an initial attempt to understand the dynamic direct shear failure in reinforced concrete slabs by considering elastic beam action to describe incipient direct shear failure conditions. The effects of load rate and beam-end restraint are investigated. Failure curves developed from elastic Timoshenko beam models are compared with experimental data on one-way slabs which failed in direct shear.

86-614
Non-Linear Vibration Analysis of Multilayer Beams by Incremental Finite Elements, Part I: Theory and Numerical Formulation
V.P. Iu, Y.K. Cheung, S.L. Lau
University of Hong Kong, Hong Kong
J. Sound Vib., 100 (3), pp 359-372 (June 8, 1985) 2 figs, 5 tables, 26 refs

KEY WORDS: Beams, Layered materials, Flexural vibrations, Nonlinear response, Finite element technique

An incremental variational equation for nonlinear motions of multilayer beams composed of stiff layers and soft cores is derived from the dynamic virtual work equation by an appropriate integration procedure. The kinematical hypotheses of Euler-Bernoulli and Timoshenko beam theories are used to describe the displacement fields of the stiff layers and cores respectively. An efficient solution procedure of incremental harmonic balance method type, with use of finite elements, is developed.

86-615
Non-Linear Vibration Analysis of Multilayer Beams by Incremental Finite Elements, Part II: Damping and Forced Vibrations
V.P. Iu, Y.K. Cheung, S.L. Lau
University of Hong Kong, Hong Kong
J. Sound Vib., 100 (3), pp 373-382 (June 8, 1985) 14 figs, 1 table, 12 refs

KEY WORDS: Beams, Layered materials, Periodic response, Nonlinear response, Viscous damping

The inclusion of simple damping of viscous type in the incremental variational equation governing the nonlinear motions of multilayer beams is described. Various problems of forced nonlinear response of three-layer sandwich beams are studied.

86-616
Moment Determination for Moving Load Systems
M.B. Wechsler
Bechtel Power Corp., Norwalk, CA
ASCE J . Struc. Engrg., 111 (6), pp 1401-1409 (June 1985) 4 figs, 3 refs

KEY WORDS: Beams, Moving loads

A new method is suggested for the design of simply supported beams subjected to moving loads. The basic idea of the new method is to replace each of the moving load systems that may travel on a beam, by a virtual system of stationary loads.

86-617
Vibrational Characteristics of Multi-Cellular Structures
T. Balendra, N.E. Shanmugan
McMaster Univ., Hamilton, Canada
ASCE J. Struc. Engrg., 111 (7), pp 1449-1459 (July 1985) 14 figs, 3 tables, 12 refs

KEY WORDS: Grids (beam grids), Boundary condition effects, Natural frequencies, Mode shapes

Experimental study is carried out to verify the grillage idealization for dynamic analysis of multi-cellular structures. Perspex material is used to construct two models of the same size, one with no web openings and the other with 25% web openings. The natural frequencies and the corresponding mode shapesare determined for two different sets of boundary conditions.

86-618
Static and Fatigue Tests on Partially Prestressed Beams
M.H. Harajli, A.E. Naaman
Univ. of Michigan, Ann Arbor, MI
ASCE J. Struc. Engrg., 111 (7), pp 1602-1618 (July 1985) 12 figs, 3 tables, 25 refs

KEY WORDS: Beams, Prestressed concrete, Fatigue tests

The fatigue behavior of 12 different sets of partially prestressed concrete beams was experimentally investigated. Typical results and observed trends are described. Throughout the tests, measurements of strains in the reinforcement, deflections, crack widths, curvatures and their variation under static and cyclic fatigue loading were systematically recorded.

86-619
Recent Research in Nonlinear Analysis of Beams
M. Sathyamoorthy
Clarkson Univ., Potsdam, NY

Shock Vib. Dig., 17 (9), pp 19-27 (Sept 1985) 140 refs

KEY WORDS: Beams, Nonlinear theories, Arches, Cables, Reviews

This literature survey deals with the static and dynamic nonlinear analysis of beams. Also included are papers about arches, cables, frames, strings, and trusses. Papers reviewed are limited to those published between 1982 and 1984. Geometric and material type nonlinearities are included. Analytical, experimental, and numerical methods are reviewed.

86-620

Consistent Hydrodynamic Mass for Parallel Prismatic Beams in a Fluid Filled Container

J.F. Loeber

Knolls Atomic Power Laboratory, Schenectady, NY

Flow-Induced Vibrations Symp., Vol. 6, Computational Aspects of Flow Induced Vibration, ASME Winter Annual Mtg., New Orleans, LA, Dec 9-14, 1984, pp 55-68, 5 figs, 5 tables, 11 refs

KEY WORDS: Beams, Fluid filled containers, Fluid-induced excitation, Submerged structures

Representation of the effects of incompressible fluid on the dynamic response of parallel beams in fluid-filled containers is developed using the concept of hydrodynamic mass. The technique is illustrated by application to analysis of an experiment involving vibration of an array of four tubes in a fluid-filled cylinder.

COLUMNS

86-621

Almost-Axial Impact on an Elastic Cantilever Column — A Theoretical Study

L.X. Ren

Tongji University, Shanghai, The People's Republic of China

J. Sound Vib., 100 (3), pp 321-337 (June 8, 1985) 9 figs, 12 refs

KEY WORDS: Columns, Elastic Properties, Impact response, Transverse shear deformation effects, Rotatory inertia effects

The process of contact between an initially straight flat-ended elastic cantilever column with rectangular cross section and a flat-ended rigid impacting mass with a small angle of incidence with respect to the axis of the column is studied theoretically.The equations of motion pertaining to the column, including the effects of shear deformation and rotary inertia, take the form of coupled second-order nonlinear partial differential equations. These are solved by using an explicit finite difference method.

86-622

Inelastic Cyclic Analysis of Imperfect Columns

M. Papadrakakis, L. Chrysos

National Tech. Univ., Athens, Greece

ASCE J. Struc. Engrg., 111 (6), pp 1219-1234 (June 1985) 8 figs, 8 refs

KEY WORDS: Columns, Steel, Cyclic loading

The hysteretic behavior of a simply supported prismatic steel column with initial out-of-straightness subjected to cyclic loading is presented. The analysis is based on the plastic hinge concept, which under the assumption of perfect plasticity together with the one-dimensional idealization of the column, has led to an elegant closed form solution for any history of axial loading. The results presented illustrate the imperfection sensitivity of column cyclic behavior.

FRAMES AND ARCHES

86-623

Nonlinear Analysis of Elastic Space Trusses

J.A. Teixeira de Freitas, J.P.B. Moitinho de Almeida, F.B.E. Virtuoso

Universidade Tecnica de Lisboa, Lisbon, Portugal

Meccanica, 20 (2), pp 144-150 (June 1985) 11 figs, 7 refs

KEY WORDS: Trusses, Elastic properties, Nonlinear theories

A displacement method based formulation is presented to perform the analysis of imperfect elastic space trusses, in the response of which the nonlinear effects developing pre- and post-instabilization of the structure are dominant. Additional forces and deformations are used to preserve symmetry in the Lagrangian description of the governing system. The external work rate is used as control variable in the numerical solution procedure, which is designed to maximize the step length and is capable of identifying and solving the occurrence of critical points in the equilibrium path.

86-624
A Newtonian Procedure for the Solution of the Kron Characteristic Value Problem
N.S. Sehmi
University of Bristol, Bristol, England
J. Sound Vib., 100 (3), pp 409-421 (June 8, 1985) 5 figs, 4 tables, 8 refs

KEY WORDS: Frames, Natural frequencies, Kron Method

A quadratically convergent Newtonian procedure is presented to determine the latent roots of the Kron matrix. The roots are found in ascending order with the certainty that none has been programmed and it performs at least 50% faster than the bisection scanning method available for the Kron matrix.

86-625
Material and Geometric Nonlinear Dynamic Analysis of Steel Frames Using Computer Graphics
S.I. Hilmy, J.F. Abel
Cornell University, Ithaca, NY
Computers Struc., 21 (4), pp 825-840 (1985) 13 figs, 17 refs

KEY WORDS: Frames, Steel, Graphic methods, Computer graphics

A promising analytical model for nonlinear dynamic analysis of steel frames is described. This approach is based on an updated Lagrangian formulation in conjunction with force-space, concentrated plasticity. The analysis is implemented in a highly interactive, adaptive fashion using computer graphics and a super-minicomputer. Several examples illustrate the effectiveness of the analysis strategy described.

86-626
Oscillations and Instability of Shallow Arch Under Two-Frequency Excitation
R.H. Plaut, J.-C. Hsieh
Virginia Polytechnic Institute and State University, Blacksburg, VA
J. Sound Vib., 102 (2), pp 189-201 (Sept 22, 1985) 14 figs, 48 refs

KEY WORDS: Arches, Stability

A shallow, sinusoidal, elastic arch with pinned ends is considered. It is subjected to a distributed load with sinusoidal spatial distribution and an amplitude comprised of two harmonic components. The equation for the response amplitude contains quadratic and cubic nonlinearities, as well as damping, and it is solved by numerical integration. The effects of the arch rise and the excitation frequencies on the critical load are investigated.

MEMBRANES, FILMS, AND WEBS

86-627
Acoustic Design for Flexible Membrane Structures
D.J. Croome
School of Architecture and Building Engineering, Claverton Down, Bath, England
Appl. Acoust., 18 (6), pp 399-433 (1985) 14 figs, 8 tables, 9 refs

KEY WORDS: Membranes, Acoustic absorption

In the past twenty years various lightweight materials have become available which have strength and durability properties enabling structures having life spans of forty years to be built. Because of the differences in geometry, scale and materials which are inherent properties of lightweight membranes the sound field has to be considered in detail. This paper reviews the current state of knowledge about the absorption and the sound transmission properties of flexible membranes and compares the results of work in American and West Germany with those obtained using a pneumatic airhouse at Bath University. The limitations of theory are discussed.

PANELS

86-628
The Transmission Coefficient of a Panel Measured with a Parametric Source
V.F. Humphrey, H.O. Berktay

University of Bath, Claverton Down, Bath, England
J. Sound Vib., 101 (1), pp 85-106 (July 8, 1985) 11 figs, 19 refs

KEY WORDS: Panels, Submerged structures, Sound transmission

The transmission coefficient of a Perspex (polymethylmethacrylate) panel 12.7 mm thick was measured at normal incidence with a parametric array being used as the source. Results obtained for the frequency range 20 to 150 kHz are presented and compared with the predictions of plane wave theory. The experimental results, which were obtained under free field conditions, are found to deviate significantly from the plane wave predictions over parts of the frequency range considered.

PLATES

86-629

Dynamic Response of a Laminated Plate With Friction Damping

Shen Zong Han
Academia Sinica, Beijing, China
J. Vib., Acoust., Stress Rel. Des., Trans. ASME 107 (4), pp 375-377 (Oct 1985) 4 figs, 1 table, 1 ref

KEY WORDS: Plates, Sandwich structures, Coulomb friction, Layered materials

A sandwich-type plate with metal facings and felt core, fastened by bolts, was studied using both test and finite-element analysis. This type of plate is cheap, light, damping-effective and without pollution; therefore, it is widely used in astronautical engineering. The tests were conducted for different felt thicknesses, bolt numbers, and fastening forces. The results show that the damping depends on friction between the plates and the felt. As compared with an identical stiffness solid plate, the damping of laminated plates can be increased up to 30 times.

86-630

Vibration of Skew Plates at Large Amplitudes Including Thermal Gradient

A. Dalamangas
University of Ioannina, Greece
Rev. Roumaine Sci. Tech., Mecanique Appl., 29 (3), pp 263-269 (1984) 3 figs, 9 refs

KEY WORDS: Skew plates, Flexural vibrations, Temperature effects

The large amplitude flexural vibrations of thin, elastic isotropic skew plates under planar temperature distribution are studied. The formulation of the problem is based on the von Karman nonlinear equations and the mathematical analysis on Galerkin's method. The degree of nonlinearity is obtained as a function of the skew angle, aspect ratio and thermal coefficient.

86-631

Transmission of Structure-Borne Sound From a Beam into an Infinite Plate

S. Ljunggren
The Aeronautical Res. Inst. of Sweden, Bromma, Sweden
J. Sound Vib., 100 (3), pp 309-320 (June 8, 1985) 11 figs, 11 refs

KEY WORDS: Beams, Plates, Structure borne vibration, Sound transmission

An analytical study of transmission of structure-borne sound from a semi-infinite beam into an infinite, isotropic plate is presented. The beam is assumed to carry a torsional, a quasi-longitudinal and bending wave and the transmission is obtained with the help of the admittances of the beam and the plate. The analysis is restricted to the case of low frequencies but is otherwise general. An interesting result from the study is that a bending wave on the beam will transfer a substantial part of its power into quasi-longitudinal and transverse waves in the plate, especially if the plate is thin compared with the beam.

86-632

A Study of the Effects of Kinematic and Material Characteristics on the Fundamental Frequency Calculations of Composite Plates

O.O. Ochoa, J.J. Engblom, R. Tucker
Texas A & M Univ., College Station, Texas
J. Sound Vib., 101 (2), pp 141-148 (July 22, 1985) 3 figs, 8 tables, 11 refs

KEY WORDS: Plates, Composite structures, Fundamental frequencies, Fiber composites, Timoshenko theory

A compendium of results illustrating the effects of plate geometry, aspect ratio, support conditions and lamina stacking sequence on the natural fundamental frequency of fiber reinforced composite plates is presented. The plates are modeled by quadrilateral finite elements that account for the effects of transverse deformation and rotary inertia, thus overcoming the shortcomings of the Kirchhoff-Love assumptions.

86-633
Vibration of Plates Immersed in Hot Fluids
S. Nagaraja Rao, N. Ganesan
Indian Institute of Technology, Madras, India
Computers Struc., 21 (4), pp 777-787 (1985) 3 figs, 9 tables, 22 refs

KEY WORDS: Plates, Submerged structures, Temperature effects, Natural frequencies, Finite element technique

The determination of natural frequencies of plates immersed in water and subjected to six types of temperature distribution is presented. The analysis is based on the finite element method. A comment on thermal buckling of plates immersed in water is also reported.

86-634
Effects of Large Amplitude and Transverse Shear on Vibrations of Triangular Plates
M. Sathyamoorthy
Clarkson University, Potsdam, NY
J. Sound Vib., 100 (3), pp 383-391 (June 8, 1985) 1 fig, 10 tables, 9 refs

KEY WORDS: Plates, Flexural vibrations, Transverse shear deformation effects, Rotatory inertia effects

An analytical investigation of large amplitude free flexural vibrations of isotropic and orthotropic moderately thick triangular plates is carried out. The effects of transverse shear, rotatory inertia, material properties, aspect ratios, and thickness parameters are studied and compared with available solutions.

86-635
Determination of the Steady State Response of a Viscoelastically Point-Supported Rectangular Plate
G. Yamada, T. Irie, M. Takahashi
Hokkaido University, Sapporo, Japan
J. Sound Vib., 102 (2), pp 285-295 (Sept 22, 1985) 7 figs, 1 table, 23 refs

KEY WORDS: Rectangular plates, Viscoelastic foundations, Sinusoidal excitation

The steady state response to a sinusoidally varying force is determined for a viscoelastically point-supported square or rectangular plate. The transverse deflection of the plate is written in a series of the product of the deflection functions of beams parallel to the edges, and the response equation is derived by the generalized Galerkin method.

86-636
Partial Coverage of Rectangular Plates by Unconstrained Layer Damping Treatments
G. Parthasarathy, C.V.R. Reddy, N. Ganesan
ISRO Satellite Centre, Bangalore, India
J. Sound Vib., 102 (2), pp 203-216 (Sept 22, 1985) 8 figs, 4 tables, 11 refs

KEY WORDS: Rectangular plates, Layered damping, Damping effects

Theoretical and experimental investigations were made to study the damping effectiveness of unconstrained partially applied damping treatments applied to rectangular plates. By using the finite element approach, different configurations of partially applied damping layer treatments were analyzed for the effectiveness in realizing maximum system damping with minimum mass of the applied damping material. The effects of partial application on the modal frequencies, loss factors and mode shapes are discussed.

86-637
Eigenvalues and Stable Time Steps for the Bilinear Mindlin Plate Element
T. Belytschko, J.I. Lin
Northwestern Univ., Evanston, IL
Intl. J. Numer. Methods Engrg., 21 (9), pp 1729-1745 (Sept 1985) 7 figs, 5 tables, 8 refs

KEY WORDS: Plates, Eigenvalue problems, Mindlin theory, Frequency analysis

Eigenvalues are obtained for the 4-node Mindlin plate element with one-point quadrature. Both isotropic and some anisotropic materials are considered, but for the latter only bounds are obtained on the eigenvalues. These eigenvalues provide stable time steps for explicit time integration algorithms.

86-638
Local Instability Tests of Plate Elements Under Cyclic Uniaxial Loading
Y. Fukumoto, H. Kusama
Nagoya Univ., Nagoya, Japan
ASCE J. Struc. Engrg., 111 (5), pp 1051-1065 (May 1985) 12 figs, 5 tables, 7 refs

KEY WORDS: Plates, Cyclic loading, Seismic response

An experimental study of the inelastic cyclic load-deformation behavior of welded built-up square box-section short columns subjected to cyclic axial loading is presented. Monotonically increased loading tests were carried out for comparison with the deformation behavior of cyclic loading tests. This paper emphasizes the development of alternating local instability of plate elements associated with cyclic loading sequences.

86-639
Free Vibration of Transverse Isotropic Annular Sector Mindlin Plates
R.S. Srinivasan, V. Thiruvenkatachari
Indian Institute of Technology, Madras, India
J. Sound Vib., 101 (2), pp 193-201 (July 22, 1985) 3 figs, 2 tables, 16 refs

KEY WORDS: Annular plates, Mindlin theory, Transverse shear deformation effects, Rotatory inertia effects, Natural frequencies

The natural frequencies of moderately thick transverse isotropic annular sector plates, as obtained by using Mindlin's theory, which includes the effect of shear deformation and rotatory inertia, are presented. An integral equation is used and results are compared with those of other investigators who have used different methods for the solution.

SHELLS

86-640
The Low Frequency Vibration of a Ribbed Cylinder, Part 1: Theory
C.H. Hodges, J. Power, J. Woodhouse
Topexpress Limited, Cambridge, England
J. Sound Vib., 101 (2), pp 219-235 (July 22, 1985) 5 figs, 15 refs

KEY WORDS: Cylindrical shells, Ribs (supports), Vibration transfer

The theory of vibration of a cylinder braced by circular T-section ribs spaced regularly along its length is presented.

86-641
The Low Frequency Vibration of a Ribbed Cylinder, Part 2: Observations and Interpretation
C.H. Hodges, J. Power, J. Woodhouse
Topexpress Limited, Cambridge, England
J. Sound Vib., 101 (2), pp 237-256 (July 22, 1985) 7 figs, 7 refs

KEY WORDS: Cylindrical shells, Ribs (supports), Vibration transfer

The vibratory behavior of ribbed cylinders is discussed. Very good agreement is obtained between theoretical modeling and measurements on a ribbed cylinder over a frequency range from zero to about three times the ring frequency. The group velocity as a function of frequency and wavenumber is studies, and agrees in considerable detail with that obtained from measured sonograms.

86-642
Wind-Excited Ovalling Vibration of a Thin Circular Cylindrical Shell
S. Katsura
Obihiro University, Obihiro, Japan
J. Sound Vib., 100 (4), pp 527-550 (June 22, 1985) 19 figs, 2 tables, 12 refs

KEY WORDS: Cylindrical shells, Wind-induced excitation, Wind tunnel testing

Vibration characteristics and growth mechanisms of wind-excited ovalling vibration of thin circular cylindrical shells which have dimensions like silos were investigates using model shells made of polyester film in a wind tunnel. Wind pressure characteristics acting on the shell, static and dynamic responses of the shell and the effect of additional air force induced by the vibration of the shell were measured. The results obtained suggest that the ovalling vibration of these kinds

of shell is excited by an aerodynamic negative damping effect when the turbulence intensity of the approaching flow is small.

86-643
The Use of the Sonogram in Structural Acoustics and an Application to the Vibrations of Cylindrical Shells
C.H. Hodges, J. Power, J. Woodhouse
Topexpress Limited, Cambridge, England
J. Sound Vib., 101 (2), pp 203-218 (July 22, 1985) 9 figs, 3 refs

KEY WORDS: Cylindrical shells, Impulse response, Vibration response spectra, Sonograms

The time-varying spectrum, or sonogram, is a familiar tool in areas of acoustics concerned with perception. Processing the impulse response of a structure at a distance from the driving point gives a direct measure of the group velocity as a function of frequency. The approach is illustrated by using simulated data from idealized models of a stretched string and a bending beam. These tests show how the features in the sonogram pictures vary with changes in the compromise between time resolution and frequency resolution.

86-644
Flow-Induced Vibration of Circular Cylindrical Structures
Shoei-Sheng Chen
Argonne National Lab., Argonne, IL
Rept. No. ANL-85-51, 469 pp (June 1985)

KEY WORDS: Circular cylinders, Fluid-induced excitation

This report summarizes the flow-induced vibration of circular cylinders in quiescent fluid, axial flow, and crossflow, and applications of the analytical methods and experimental data in design evaluation of various system components consisting of circular cylinders.

86-645
Resonantly Forced Surface Waves in a Circular Cylinder
J.W. Miles
Univ. of California, San Diego, CA
J. Fluid Mechanics 149, pp 15-31 (1984)

KEY WORDS: Circular cylinders, Fluid-filled containers

The weakly nonlinear, weakly damped response of the free surface of a liquid in a vertical circular cylinder that is subjected to a simple harmonic, horizontal translation is examined by extending the corresponding analysis for free oscillations The problem is characterized by three parameters, alpha, beta and d/a, which measure damping, frequency offset (driving frequency-natural frequency), and depth/radius.

86-646
Exact Solution for Large Amplitude Free and Forced Oscillation of a Thin Spherical Shell
K. Mukherjee, S.K. Chakraborty
University of Burdwan, West Bengal, India
J. Sound Vib., 100 (3), pp 339-342 (June 8, 1985) 8 refs

KEY WORDS: Spherical shells, Exact methods, Oscillation

The title problem is analyzed on the basis of the finite deformation theory of elasticity. The material of the shell is considered neo-Hookean. The governing equation is simplified for thin spherical shells. Exact expressions for the displacement field are derived for free oscillation and forced oscillations with prescribed pressure differences.

86-647
Nonlinear Three-Dimensional Resonance Analysis of Shells
A. Tesár
Czechoslovak Academy of Sciences, Bratislava, Czechoslovakia
Computers Struc., 21 (4), pp 797-805 (1985) 9 figs, 12 refs

KEY WORDS: Shells, Resonant response

This study details geometrically and physically nonlinear analysis of thin shells in resonance regions of vibration. Generalized analysis of motion with implementation of the FETM-method and of updated Lagrangian formulation is also studied. Utilization of the multigrid spatial simulation mesh for geometric representation of a shell as well as of the anisotropy of material is presented.

86-648
Free Vibration of Longitudinally Stiffened Prismatic Shells With and Without Partitions
T. Irie, G. Yamada, H. Ida
Hokkaido University, Sapporo, Japan
J. Sound Vib., 102 (2), pp 229-241 (Sept 22, 1985) 7 figs, 1 table, 15 refs

KEY WORDS: Stiffened shells, Natural frequencies, Mode shapes

An analysis is presented for the free vibration of an unpartitioned or a longitudinally partitioned rectangular prismatic shell stiffened at the edges and the joints. The governing equations of free vibration of a side wall or an interior plate are written in a matrix differential equation by using the transfer matrix. The method is applied to two stiffened prismatic shells with structural symmetry, and the natural frequencies and the mode shapes of vibration are calculated numerically giving the results.

86-649
Chladni's Law and the Modern English Church Bell
R. Perrin, T. Charnley, H. Banu, T. Rossing
Loughborough University of Technology, Loughborough, England
J. Sound Vib., 102 (1), pp 11-19 (Sept 1985) 4 figs, 4 tables, 8 refs

KEY WORDS: Bells, Normal modes

Extensive previously reported experimental data on the normal modes of an English church bell is analyzed with use of a modified version of Chladni's law. Excellent fits are obtained in almost every case provided certain conditions, for which a theoretical basis is presented, are satisfied. Some conclusions are drawn about the validity of a previously proposed theory of mode production mechanisms for the church bell.

RINGS

86-650
On the In-Plane Vibrations of Rotating Rings
W.B. Bickford, E.S. Reddy
Arizona State Univ., Tempe, AZ
J. Sound Vib., 101 (1), pp 13-22, (July 8, 1985) 3 figs, 12 refs

KEY WORDS: Rings, Extensional deformation effects, Transverse shear deformation effects, Rotatory inertia effects

The general problem of the in-plane vibrations of a rotating ring is investigated. The potential and kinetic energy functionals including the effects of extensional and shear deformation and of rotatory inertia respectively are derived. The governing differential equations for the inextensional case are derived by using Hamilton's principal. Numerical studies are presented.

PIPES AND TUBES

86-651
Dynamics of Tubes in Fluid with Tube-Baffle Interaction
S.S. Chen, J.A. Jendrzejczyk, M.W. Wambsganss

Argonne National Lab, Argonne, IL
Rept. No. CONF-841201-2, 17 pp (1984) (pres. at the ASME winter annual meeting, New Orleans, LA Dec 9, 1984) DE84007284/GAR

KEY WORDS: Tubes, Baffles, Fluid-induced excitation

Three series of tests are performed to evaluate the effects of tube to tube-support-plate (TSP) clearance on tube dynamic characteristics and instability phenomena for tube arrays in crossflow. Test results show that for relatively large clearances, tubes may possess TSP-inactive modes in which the tubes rattle inside some of the tube-support-plate holes, and that the natural frequencies of TSP-inactive modes are lower than those of TSP-active modes, in which the support plates provide knife-edge type support.

86-652
Asymptotic Expansion of Resonance Frequencies of Elastic Tube Bank in a Liquid
J. Planchard, M.I. Zahir
Direction des Etudes et Recherches, Electricite de France, Clamart, France
Flow-Induced Vibrations Symp., Vol. 6, Computational Aspects of Flow Induced Vibration, ASME Winter Annual mtg., New Orleans, LA, Dec 9-14, 1984, pp 17-25, 2 figs, 2 tables, 18 refs

KEY WORDS: Tube arrays, Fluid-induced excitation, Resonant frequencies

A technique for computation of the resonance frequencies of an elastic tube bundle immersed in a liquid at rest is presented.The bundle is assumed to be spatially periodic and of large dimensions with regard to the tube pitch. The fluid velocity potential is set in the form of an asymptotic expansion for which the partial differential equations relating to each term are derived.

86-653
A Simplified Finite Element for Added Mass and Inertial Coupling in Arrays of Cylinders
R.E. Harris, M.A. Dokanish, D.S. Weaver
McMaster University, Hamilton, Ontario, Canada
Flow-Induced Vibration Symp., Vol. 6, Computational Aspects of Flow Induced Vibration, ASME Winter Annual mtg., New Orleans, LA, Dec 9-14, 1984, pp 27-38, 8 figs, 1 table, 13 refs

KEY WORDS: Tube arrays, Fluid-induced excitation, Finite element technique

A simplified finite element has been developed for modeling the added mass and inertial coupling arising when clusters of cylinders vibrate in a quiescent fluid. The element, which is based on two dimensional potential flow theory, directly couples two adjacent beam elements representing portions of the adjacent cylindrical structures. The primary advantage of this approach over existing methods is that it does not require the discretization of the surrounding fluid and, therefore, is computationally much more efficient.

86-654
On the Symmetry of the Interaction Matrix in Case of Hydroelastic Problem of Cylindrical Structural Components Applicable in Energetical Structures
A.B. Golovkina, V.A. Dzhupanov, O.P. Yanatchkov
Alma-Ata O.T. Faculty, (UKSDI) Alma-Ata, USSR
Flow-Induced Vibrations Symp., Vol. 6, Computational Aspects of Flow Induced Vibration, ASME Winter Annual mtg., New Orleans, LA, Dec 9-14, 1984, pp 39-54, 3 figs, 2 tables, 21 refs

KEY WORDS: Tube arrays, Fluid-induced excitation, Cylinders

Structures consisting of cylindrical components with parallel axes have important applications in nuclear technology, offshore oil extraction technology, in different radio, TV and acoustical arrays, etc. The vibration of such structures in liquid gives rise to dynamical interactions of the components through the liquid. This interaction of all components can be described by a specific matrix, the elements of which are constructed in terms of cylindrical functions.

86-655
SHAPS-2: A Three-Dimensional Computer Program for Linear/Non-Linear, Static/Dynamic Analyses of Piping Systems
C.Y. Wang
Argonne National Lab., Argonne, IL
Rept. No. Conf-850670-11, 13 pp (1985) DE85010500/GAR

KEY WORDS: Pipelines, Three-dimensional problems, Nuclear reactors, Fluid-structure interaction, Computer programs

A three-dimensional computer program for linear/nonlinear, static/dynamic analyses of reactor-piping systems under various accident loads is described. In the analysis, the hydrodynamic calculation can be performed in the implicit or semi-implicit manner. The structure response can be calculated using either a purely explicit or implicit time-integration scheme. Coupling between the fluid and structure is achieved by utilizing either the implicit-explicit of implicit-implicit link.

86-656
Computer Program for the Determination of Noise Propagation in Branched Piping Systems (Programmsystem zur Bestimmung der Schallausbreitung in verzweigten Rohrleitungssystemen)
K. Wacker
Institut für Werkzeugmaschinen der Universität Stuttgart, Fed. Rep. Germany
Industrie Anzeiger 107 (47), pp 35-36 (June 12, 1985) 4 figs, 2 refs (in German)

KEY WORDS: Computer programs, Hydraulic systems, Pipelines, Fluid-induced excitation

A computer program, HYDRO, is described for the calculation of fluid-induced noise in branched piping systems. The calculated results are verified by experimental data. The accuracy of calculations enable its application in almost any noise reduction problems of hydraulic systems. The program is written in BASIC and FORTRAN IV.

86-657
Effect of a Spring Support on the Stability of Pipes Conveying Fluid
Y. Sugiyama, Y. Tanaka, T. Kishi, H. Kawagoe
Tottori University, Koyama, Tottori, Japan
J. Sound Vib., 100 (2), pp 257-270 (May 22, 1985) 8 figs, 3 tables, 20 refs

KEY WORDS: Pipes, Fluid-filled containers, Springs, Elastic supports

This paper deals with the effect of an intermediate lateral spring support on the stability of a cantilevered tubular pipe conveying fluid. The governing equation of motion is case into a matrix form by applying the Galerkin method. In the flutter analysis the material damping is taken into account. Comparisons are made between the theoretical and experimental results.

86-658
Optimum Design of Submarine Suspended Pipelines
Z. Huang, A. Seireg
Research Institute of Petroleum Exploration and Development, Beijing, People's Rep. of China
J. Energy Resources Tech., Trans. ASME 107 (3), pp 335-341 (Sept 1985) 11 figs, 2 tables, 10 refs

KEY WORDS: Underwater pipelines, Wave forces, Design techniques, Vibration control

The concept of suspending a pipeline under the ocean surface is investigated in the reported study. An optimum design algorithm is developed which can minimize the dynamic oscillation and the tensile stress of the pipeline resulting from the wave excitation. Numerical examples are given to illustrate the optimization procedure.

DUCTS

86-659
The Propagation of Sound in Ducts Lined With Circumferentially Non-Uniform Admittance
P.G. Vaidya
Washington State University, Pullman, Washington
J. Sound Vib., 100 (4), pp 463-475 (June 22, 1985) 2 figs, 6 refs

KEY WORDS: Ducts, Sound waves, Wave propagation, Acoustic linings

Closed form solutions are obtained to a problem of sound propagation in a duct with circumferentially nonuniform admittance. Non-separable solutions are developed to obtain a closed form solution to the problem. The non-separable modes are sum of sub-modes, which satisfy the wave equation but not the boundary conditions. Expressions are obtained for the sub-modal distribution functions, which ensure that together the sub-modes shall form a wave packet which will satisfy the boundary conditions.

86-660
Multiple Transonic Shock-Wave/Turbulent Boundary-Layer Interaction in a Circular Duct
D. Om, M.E. Childs
University of Washington, Seattle, Washington
AIAA J., 23 (10), pp 1506-1511 (Oct 1985) 11 figs, 22 refs

KEY WORDS: Duct, Shock wave-boundary layer interaction, Turbulence

An experimental study is describe din which detailed pilot, static, and wall pressure measurements have been obtained for multiple transonic shock-wave/turbulent bondary-layer interactions in a circular duct. The details of the flowfield show the formation of a series of normal shock waves with successively decreasing strength and decreasing distance between the successive shock waves up to the point where a terminal shock occurs. A one-dimensional flow model based on the boundary-layer displacement thickness is postulated to explain the formation of the series of normal shock waves.

BUILDING COMPONENTS

86-661
RC Structural Walls: Seismic Design for Shear
A.E. Aktan, V.V. Bertero
Louisiana State Univ., Baton Rouge, LA
ASCE J. Struc. Engrg., 111 (8), pp 1775-1791 (Aug 1985) 5 tables, 21 refs

KEY WORDS: Walls, Reinforced concrete, Sheer strength, Seismic design, Provisions of 1982 UBC, ACI 318-83, and ATC 3-6 pertaining to seismic shear design of slender walls in mid-rise construction are evaluated. Recommendations are formulated to improve the current shear design procedures by relating the shear strength demands to the actual axial-flexural supply, and incorporating the actual shear resisting mechanisms in predicting shear strength supply of walls.

ELECTRIC COMPONENTS

ELECTRONIC COMPONENTS

86-662
The Measurement of the Free Field Impulse Response of Microphones in a Laboratory Environment
J. Downes, S.J. Elliott
University of Surrey, Guildford, England
J. Sound Vib., 100 (3), pp 423-443 (June 8, 1985) 13 figs, 12 refs

KEY WORDS: Microphones, Impulse response, Transfer functions

A method is presented for measuring the free field frequency and impulse response of microphones by using a pulse technique in an ordinary laboratory environment. To illustrate the use of the method, the free field frequency response and free field correction curves of a one inch instrumentation microphone are measured. The method is then used to measure the pressure which occurs at the center of the flat end-face of a long cylinder when excited by an impulse of acoustic pressure propagating in the free field from various angles of incidence.

DYNAMIC ENVIRONMENT

ACOUSTIC EXCITATION

86-663
Identification of the Acoustical Properties of a Ground Surface
D. Habault, G. Corsain
Laboratoire de Mecanique et d'Acoustique, Centre National de la Recherche Scientifique, Marseille Cedex, France
J. Sound Vib., 100 (2), pp 169-180 (May 22, 1985) 4 figs, 8 refs

KEY WORDS: Ground surface, Acoustic properties, Impedance technique, Parameter identification technique

A method of identifying the acoustical characteristics of a ground surface is presented. The unknowns are determined from sound-level measurements at a few points on the ground. The algorithm used is based upon the least-square minimization. A local reaction model of the ground surface is used, and the ground is characterized by one complex parameter, the specific normal impedance. Two types of ground have been studies; a comparison between theoretical and experimental results is presented.

86-664
The Influence of Waveguide Reflections and System Configuration on the Performance of an Active Noise Attenuator
R.F. La Fontaine, I.C. Shepherd
Commonwealth Scientific and Industrial Research Organization, Melbourne, Australia
J. Sound Vib., 100 (4), pp 569-579 (June 22, 1985) 8 figs, 9 refs

KEY WORDS: Active attenuation, Acoustic absorption, Active noise control, Geometric effects, Ducts

Reflections of sound from waveguide terminations can play a major role in the performance of a random noise active attenuator. Their influence depends on the direction reflections propagate along the waveguide and on the configuration of the attenuator. Upstream and downstream reflections are therefore important parameters to be considered when choosing the configuration best suited for a particular application. Theoretical and experimental results are presented, showing that waveguide reflections interact with other major parameters of a random noise attenuator.

86-665
Noise Reduction in Instrumentation Technology (9) (Geräuschminderung in der Gerätetechnik)
G. Herklotz, W. Krause, D. Schick, J. Thümmler

Feingerätetechnik, 34, (9) pp 415-420 (1985), 21 figs, 8 refs (in German)

KEY WORDS: Noise reduction, Machinery noise

Recommendations for the reduction of impact noise are discussed. Among them are the elimination or reduction of impact points, reduction of impact impulse, controlling impact excitation. By changing the duration of impact, structural modification techniques include altering the shape of impact locations, use of perforated surfaces, surface laminations, and encapsulation.

86-666

Noise Reduction in the Instrument Technology (4) (Geräuschminderung in der Gerätetechnik)

G. Herklotz, W. Krause, D. Schick, J. Thummler

Feingeratetechnik, 34 (4), pp 179-182 (1985) 3 figs, 7 refs (in German)

KEY WORDS: Noise reduction, Machinery noise, Structural modification techniques, Vibration damping, Vibration absorption (materials)

In this continuous series basic and methodical knowledge concerning the noise generation and reduction is presented. Calculations for the reduction of air-borne noise by means of structural modification of plate-shaped directional machinery components are presented. Noise reduction by means of damping and absorption is also discussed.

86-667

Long Range Downwind Propagation of Low-Frequency Sound

W.L. Willshire

NASA Langley Res. Ctr., Hampton, VA

Rept. No. NASA-TM-86409, 21 pp (Apr 1985) N85-26318/4/GAR

KEY WORDS: Sound waves, Wave propagation, Wind turbines

The propagation of low-frequency noise outdoors was studied using as the source a large 4-megawatt horizontal axis wind turbine. Acoustic measurements were made with low-frequency microphone systems placed on the ground at five downwind sites ranging from 300 m to 10,000 m away from the wind turbine. The harmonic levels, when plotted versus propagation distance, exhibit a 3 dB per doubling of distance divergence. Two plausible explanations identified for this cylindrical spreading behavior were propagation of the low frequency wind turbine noise via a surface wave and downwind refraction.

86-668

Scattering of an Acoustic Field by a Free Jet Shear Layer

A. Guédel

Office National d'Etudes et de Recherches Aérospatiales, Chatillon Cedex, France

J. Sound Vib., 100 (2), pp 285-304 (May 22, 1985) 17 figs, 23 refs

KEY WORDS: Sound waves, Wave scattering

Scattering of an acoustic field propagating through a large wind-tunnel jet shear layer is studied. For a monochromatic wave, the scattering effects are mainly spectral broadening of the incident peak and amplitude and phase fluctuations of the wave. These effects have been studied both experimentally through a parametric study and theoretically by carrying out analyses based on single scattering methods.

86-669

On the Variation and Invertibility of Room Impulse Response Functions

J. Mourjopoulos

University of Southampton, Southampton, England

J. Sound Vib., 102 (2), pp 217-228 (Sept 22, 1985) 9 figs, 2 tables, 12 refs

KEY WORDS: Acoustic response, Rooms, Impulse response

Results concerning variations in impulse response functions measured in different rooms are presented. The variation of these functions for changing source and receiver positions and orientation is examined by assessing the change in energies of the direct and reflected signal components. The various source/receiver positions and orientation examined during these tests correspond to typical positions occupied by human speakers in rooms. It was found that the response functions changed drastically with the variation of these recording parameters.

86-670

Acoustic Intensity

Proc. of the 2nd International Congress, Senlis, France, Sept 23-26, 1985

Avail. CETIM, 52, avenue Felix-Louat, B.P. 67, 60304, Senlis, France

KEY WORDS: Acoustic intensity method

The first International Congress held in Senlis in 1981 saw the beginnings and spread of acoustic intensity technology in the acoustic world. This Congress witnessed a new weapon against noise, the intensity meter, and opened new territories for investigation, namely the vectorial acoustics. The eighty papers presented at this Congress were arranged into sessions on Instrumentation; Vector Acoustics; Radiation of Sound; Intensity in the Presence of Flow; Intensity in Structures; Sound Power; Source Localization; and Impedance-Absorption-Transmission

SHOCK EXCITATION

86-671

Three-Dimensional Finite Element Impact Analysis of a Nuclear Waste Truck Cask

J.D. Miller
Sandia National Labs., Albuquerque, NM
Rept. No. SAND-84-1899C, CONF-850670-15, 11 pp (1985) DE85010653/GAR

KEY WORDS: Nuclear waste depositories, Shipping containers, Impact response, Finite element technique, Computer programs

Three-dimensional finite element impact analysis of a hypothetical accident event for the preliminary design of a shipping cask, used to transport radioactive waste by standard tractor-semitrailer truck is presented. The nonlinear dynamic structural analysis code Dyna3D was used to calculate the effects of the cask's closure-end impacting a rigid frictionless surface on an edge of its external impact limiter after a 30-foot fall.

86-672

Impactor Interaction with Concrete Structures — Local Effects

H. Adeli, R.L. Sierakowski
Ohio State Univ., Columbus, Ohio
Shock Vib. Dig., 17 (9), pp 3-16 (Sept 1985) 5 figs, 4 tables, 27 refs

KEY WORDS: Concrete, Impact response, Reviews

This paper focuses on the local effect of solid impactors acting on concrete structures. Available formulas for predicting the penetration depth, scabbing thickness, and perforation thickness of solid impactors acting on concrete structures are reviewed and compared.

86-673

Geophysical Input for Seismic Hazard Analysis

C.C. Schoof
Ph.D. Thesis, Stanford Univ., 201 pp (1985) DA8506253

KEY WORDS: Earthquake prediction, Normal modes, Spheres, Layered materials, Fracture properties

The normal mode method is used to compute the elastic response of a layered sphere to a prescribed (or simulated) fault rupture process. High frequency synthetic time histories are obtained by a weighted superposition of normal modes corresponding to P-SV and SH wave motion. These synthetics are then used to study the random variables related to site response given an event size and location. By evaluating these random variables on a more local level, the averaging effects over fault type and earth structure are avoided. The analysis of these synthetic ground motion records can provide information on the azimuthal dependence of the predicted site response, as well as allow us to evaluate the importance of other random variables associated with strong ground motion response.

86-674

Constitutive Modeling for Blast-Induced Wave Propagation

E.C. Drumm
Univ. of Tennessee, Knoxville, TN
Rept. No. AFESC/ESL-TR-84-45, 27 pp (Mar 1985) AD-A153 576/4/GAR

KEY WORDS: Shock wave propagation, Soils, Constitutive equations

The description of stress-time history acting on a buried structure is a major source of error in the analysis of underground structures to weapons loadings. The stress wave propagating spherically from the weapon is attenuated as it travels from the source. This attenuation is a function of the inelastic response of the soil, and results in an increase in the loading *rise* time or decrease in the loading rate. Since the inelastic soil response is a function of the loading rate, a wave propagation analysis should be conducted to determine the stresses on the structure. One-dimensional wave propagation experiments and impact tests with various soils are reviewed, and the attenuation as a function of the soil stress-strain response is discussed.

86-675
Theoretical and Experimental Study of Nonadiabatic Transonic Shock/Boundary-Layer Interaction
G.R. Inger, F.T. Lynch, M.F. Fancher
Iowa State University, Ames, Iowa
AIAA J., 23 (10), pp 1476-1482 (Oct 1985) 12 figs, 16 refs

KEY WORDS: Shock wave-boundary layer interaction, Temperature effects

A theoretical and experimental study of how surface heat transfer alters the local and global effects of a shock-wave/boundary-layer interaction on a nonadiabatic supercritical airfoil is described. The present experiments show that even modest surface temperature differences above the adiabatic value cause significant drag increases and lift decreases that are much higher than observed under shockless subcritical conditions.

86-676
The Critical Excitation and Response of Simple Dynamic Systems
B.D. Westermo
San Diego State University, San Diego, CA
J. Sound Vib., 100 (2), pp 233-242 (May 22, 1985) 9 figs, 4 refs

KEY WORDS: Critical excitation method

A method for defining the critical excitations and responses of dynamic systems is examined. The critical excitations are those functions which maximize some response norm with respect to the constraints placed on the admissible excitations. A class of critical responses for linear, elastoplastic and hysteretic single degree of freedom systems is studied, showing the frequency and amplitude relations for these solutions.

VIBRATION EXCITATION

86-677
Wind-Excited Behaviour of Structures IV
D.J. Johns
City Polytechnic of Hong Kong, Kowloon, Hong Kong
Shock Vib. Dig., 17 (7), pp 17-34 (July 1985), 3 tables, 204 refs

KEY WORDS: Wind-induced excitation, Vortex shedding, Flutter, Galloping, Turbulence

This article reviews recent literature on wind-excited behavior of structures. Among the phenomena considered are those due to vortex shedding, galloping, flutter, divergence, and turbulence. Theoretical and experimental (model and full-scale) studies are included, as are techniques to alleviate wind-excited behavior.

86-678
Static and Dynamic Pressure Measurements on a NACA 0012 Airfoil in the Ames High Reynolds Number Facility
J.B. McDevitt, A.F. Okuno
NASA Ames Res. Ctr., Moffett Field, CA
Rept. No. A-85100, NASA-TP-2485, 78 pp (June 1985) N85-27823/2/GAR

KEY WORDS: Airfoils, Aerodynamic loads

The supercritical flows at high subsonic speeds over a NACA 0012 airfoil were studied to acquire aerodynamic data suitable for evaluating numerical-flo codes. The measurements consisted primarily of static and dynamic pressures on the airfoil and test-channel walls. Shadowgraphs were also taken on the flow field near the airfoil.

86-679
Flow Instabilities in Transonic Small-Disturbance Theory
M.H. Williams, S.R. Bland, J.W. Edwards
Purdue University, West Lafayette, Indiana
AIAA J., 23 (10), pp 1491-1496 (Oct 1985) 9 figs, 10 refs

KEY WORDS: Airfoils, Fluid-induced excitation

The dynamics of unsteady transonic small-disturbance flows about two-dimensional airfoils is examined, with emphasis on the behavior in the region where the steady-state flow is nonunique. It is shown that nonuniqueness results from an extremely long time scale instability that occurs in a finite Mach number and angle of attack range. The similarity scaling rules for the instability are presented, and the possibility of similar behavior in the Euler equations is discussed.

86-680
Frequency Fluctuations in Noisy Oscillators
Z. Schuss, C. Tier, B.J. Matkowsky
Northwestern Univ., Evanston, IL
SIAM J. Appl. Math., 45 (5), pp 843-854 (Oct 1985) 2 figs, 12 refs

KEY WORDS: Oscillators

Frequency and period fluctuations in a nonlinear oscillator driven by Gaussian white noise are studied. The random period is defined as the random time between two consecutive zero crossings by the random phase plane trajectory, and the random frequency as the number of such zero crossings per unit of time. These quantities are shown to be related by renewal theory.

86-681
Minimizing Residual Vibration for Point-to-Point Motion
P.H. Meckl, W.P. Seering
Massachusetts Institute of Technology, Cambridge, MA
J. Vib., Acoust., Stress Rel. Des., Trans. ASME, 107 (4), pp 378-382 (Oct 1985) 11 figs, 9 refs

KEY WORDS: Positioning devices, Vibration control, Forcing function, Amplitude attenuation

An appropriately shaped forcing function for moving a dynamic system over an incremental distance with minimum residual vibration is described. The function is constructed by combining harmonics of a ramped sinusoid function so that minimum energy is introduced to the system at its resonant frequencies. A test fixture to evaluate this approach is described and experimental results are given.

86-682
Discrete-Element Acoustic Analysis of Submerged Structures Using Doubly Asymptotic Approximations
J.A. DeRuntz
Lockheed Missiles and Space Co., Inc., Palo Alto, CA
Rept. No. LMSC-F035672, 27 pp (Apr 1985)
AD-A154 959/1/GAR

KEY WORDS: Doubly asymptotic approximation, Submerged structures, Fluid-structure interaction, Spherical shells

Doubly asymptotic approximations have been found to offer significant advantages for the treatment of steady-state fluid-structure interaction in vibration, acoustic-radiation, and acoustic-scattering problems for complex submerged structures. This paper describes the theoretical foundations, development, and verification of two boundary-element/finite-element processors that implement this approach.

MECHANICAL PROPERTIES

DAMPING

86-683
Vibration and Shock Isolation Performance of a Semi-Active "On-Off" Damper
S. Rakheja, S. Sankar
Institute for Manufacturing Technology, National Research Council, Canada
J. Vib., Acoust., Stress Rel. Des., Trans. ASME, 107 (4), pp 398-403 (Oct 1985) 16 figs, 3 tables, 10 refs

KEY WORDS: Dampers, Shock isolation, Vibration isolation, Active isolation

The concept of an on-off damper employing the feedback signals from directly measurable variables is proposed. A control scheme utilizing the directly measurable relative position and relative velocity signals to produce the command signal is configured. The on-off damping mechanism can be achieved through the modulation of orifice area in a conventional hydraulic damper, using a two position on-off value driven by the command signal. The shock and vibration isolation characteristics of the proposed on-off damper are evaluated through computer simulations.

86-684

On Damping of Large Honeycomb Structure

M.L. Drake, M.P. Bouchard
Univ. Of Dayton Research Inst., Dayton, OH
J. Vib., Acoust., Stress Rel. Des., Trans. ASME, 107 (4), pp 361-366 (Oct 1985) 13 figs, 3 tables, 11 refs

KEY WORDS: Damping, Design techniques, Honeycomb structures, Box type structures

A study of methods for passive damping of a large (total mass of about 4000 lbs.) honeycomb box structure is described. Both classical and finite element procedures (MAGNA) are used. The aim of the design is to develop as much damping as possible for the floor resonant modes in the frequency range from 80 to 300 Hz.

86-685

Equivalent Linearizations for Practical Hysteretic Systems

K.E. Beucke, J.M. Kelly
HOCHTIEF, AG, Frankfurt, West Germany
Intl. J. Nonlin. Mech., 23 (4), pp 211-238 (1985) 9 figs, 13 refs

KEY WORDS: Coulomb damping, Viscous damping, Equivalent linearization method, Base isolation, Seismic isolation

Experimental testing of a friction damped base isolation system has indicated a need for a new model of friction damping and for an appropriate equivalent linearization technique. The model for the damping adopted is a combination of viscous damping, constant Coulomb friction and linear Coulomb friction. This model is incorporated into the equation of motion for a single-degree-of-freedom system and the exact solutions are given for free vibrations and for steady-state vibrations excited by a harmonic force.

86-686

The Application of Viscoelastic Passive Damping to Satellite Equipment Support Structures

R. Ikegami, D.W. Johnson, W.J. Walker, C.J. Beck
The Boeing Aerospace Company, Seattle, WA
J. Vib., Acoust., Stress Rel., Des., Trans. ASME, 107 (4), pp 367-374 (Oct 1985) 15 figs, 6 tables, 11 refs

KEY WORDS: Spacecraft equipment response, Viscoelastic damping, Modal analysis, Acoustic tests

Results of an ongoing study to investigate the use of viscoelastic passive damping technology to decrease the vibroacoustic response of avionics equipment in typical satellite systems are presented. The design and analysis of damping treatments were first carried out on a component test structure using finite element analysis and the modal strain energy method. A series of modal survey and acoustic tests on the test structure were performed to validate the analytical procedures and evaluate the effectiveness of the designed damping treatments.

86-687

Thermal and Electromagnetic Damping Analysis and Its Application

U. Lee
Ph.D. Thesis, Stanford Univ., 308 pp (1985)
DA8511326

KEY WORDS: Electromagnetic damping, Thermal damping, Spacecraft components

The purpose of this research is to estimate analytically the thermal damping due to thermal currents and the electromagnetic damping due to electric conduction currents based on coupled thermoelasticity and coupled magnetoelasticity. Also, the influence of thermal damping on the aeroelastic stabilities is investigated based on the theory of two-dimensional aerodynamics. The study of effects of structural and geometrical constraints on damping loss factors are investigated. Optimum conditions for the maximum damping, which may be useful on the stage of system design, are also investigated.

86-688

Extended Damping Models for Vibration Data Analysis

J.A. Fabunmi
University of Maryland, College Park, Maryland
J. Sound Vib., 101 (2), pp 181-192 (July 22, 1985) 4 figs, 11 refs

KEY WORDS: Damping coefficients, Mathematical models

A simple 3 degree of freedom spring-mass-damper system has been used to investigate the response of structural systems when the damping mechanisms are more general than viscous or hysteretic damping. The damping forces in the dashpots were assumed proportional to a general power of the relative velocity, which led to a system of equations having a frequency dependent damping matrix.

86-689
Modal-Space Active Damping of a Beam-Cable Structure: Theory and Experiment
G.R. Skidmore, W.L. Hallauer, Jr.
Virginia Polytechnic Institute and State University, Blacksburg, Virginia
J. Sound Vib., 101 (2), pp 149-160 (July 22, 1985) 6 figs, 2 tables, 13 refs

KEY WORDS: Active damping, Active vibration control, Active flutter control, Experimental data

A theory of multiple-actuator modal-space active damping (control) of individual structural vibration modes is reviewed. An experiment is described in which the control technique was applied to a laboratory beam-cable structure. Active damping was produced in the three lowest modes (all under 10 Hz) of the structure by a feedback control system consisting of a single velocity sensor, and analog controller, and three force actuators.

86-690
Viscoelastic Analysis of Multi-Body Systems Using the Finite Element Method
A. Shabana
University of Illinois at Chicago, Chicago, Illinois
J. Sound Vib., 100 (2), pp 271-284 (May 22, 1985) 10 figs, 14 refs

KEY WORDS: Viscoelastic damping, Finite element technique

A study of the effect of viscoelastic material damping on the dynamic response of multibody systems, consisting of interconnected rigid, elastic and viscoelastic components, is presented. The motion of each elastic or viscoelastic body is identified by using three sets of modes: rigid body, reference and normal modes.

86-691
A Perturbation Technique for Gyroscopic Systems with Small Internal and External Damping
L. Meirovitch, G. Ryland
Virginia Polytechnic Institute and State University, Blacksburg, Virginia
J. Sound Vib., 100 (3), pp 393-408 (June 8, 1985) 2 figs, 3 tables, 11 refs

KEY WORDS: Gyroscopes, External damping, Perturbation theory

In a previous paper, a perturbation analysis was used to derive the response of a gyroscopic system with small internal damping. This paper extends the approach to the case of external damping, which is characterized not only by symmetric coefficients multiplying velocities but also by skew symmetric coefficients multiplying displacement, where the latter terms are known as circulatory. A numerical example is presented.

86-692
Separation and Determination of Combined Dampings from Free Vibrations
F. Badrakhan
Kuwait University, Kuwait
J. Sound Vib., 100 (2), pp 243-255 (May 22, 1985) 10 figs, 17 refs

KEY WORDS: Damping effects

The effects of combined viscous with Coulomb damping, Reid damping and bilinear hysteretic damping on the free motion of an oscillator are studied directly by integration of the differential equations of motion and by the use of first integrals for the first time. The amplitude decay during the free motion is considered in order to separate and determine the various types of damping.

86-693
An Energy Approach to Linearizing Squeeze-Film Damper Forces
E.J. Hahn
The University of New South Wales, Kensington, New South Wales, Australia
IMechE, Proc., 199 (C1), pp 57-63 (1985) 7 figs, 1 table, 7 refs

KEY WORDS: Squeeze-film dampers, Stiffnes coefficients, Damping coefficients

Analyses of multi-degree of freedom rotor-bearing systems incorporating nonlinear elements, such as squeeze-film dampers, generally necessitate time consuming transient solution. This paper presents a general technique for linearizing the nonlinear element forces using equivalent stiffness and damping coefficients with energy dissipation and energy storage-release concepts. The approach is illustrated and tested for both centrally preloaded squeeze-film dampers and for squeeze-film dampers without centralizing springs under a combination of unidirectional and unbalance loading.

86-694
Measurement of Damping of Graphite Epoxy Materials
M.J. Crocker
Auburn Univ., Auburn, AL
Rept. No. PR-6, NASA-CR-175663, 11 pp (Apr 1, 1985) N85-23931/7/GAR

KEY WORDS: Material damping, Graphite, Measurement techniques

The design of an experiment to measure the damping of a cylindrical graphite-epoxy specimen with a three point support and a knife edge support is described as well as equipment used in tests conducted to determine the influence of the support at the two ends of the specimen and to simulate an idealized free-free boundary condition at the two edges. A curve fitting technique is used to process the frequency response data obtained.

FATIGUE

86-695
The Effect of Overload Cycles on Fatigue Crack Propagation in Structural Steels
M. Drew
Ph.D. Thesis, Univ. of New South Wales (Australia) (1984)

KEY WORDS: Fatigue life, Steel

A detailed study has been made of the effect of a single peak overload cycle on the rate and mechanisms of fatigue crack propagation in two structural steels. Compact tension test-pieces (B = 15 mm) of controlled rolled, cerium treated C-Mn and C-Mn-Nb-V steels were used.

86-696
Corrosion Fatigue Initiation and Short Crack Growth in an Aluminum Alloy
Yen-How Huang
Ph.D. Thesis, Univ. of Illinois, Urbana-Champaign, 174 pp (1985) (DA8511619)

KEY WORDS: Fatigue life, Aluminum

A prepitted specimen with a single pit provided a favorable condition for observing crack initiation. Initiation and early growth of corrosion fatigue cracks was followed optically in pre-pitted Al-5454-H32 specimens. Supplementary fractographic, electrochemical and microstructural observations were made.

86-697
Tensile Fatigue Damage and Degradation of Random Short-Fiber SMC Composite
E. S.-M. Chim
Ph.D. Thesis, Univ. of Illinois, Urbana-Champaign, 169 pp (1985) DA8511596

KEY WORDS: Fatigue life, Composite materials

Fatigue damage and degradation in a random short-fiber SMC-R50 composite were investigated experimentally and theoretically. In the study of homogeneous damage, experiments were conducted to examine fundamental mechanisms and characteristics of fatigue damage and its evolution. The statistical nature of microcracks was evaluated by the introduction of damage distribution functions.

86-698
On the Stochastic Modeling of Fatigue Crack Growth
K. Ortiz
Ph.D. Thesis, Stanford Univ., 120 pp (1985) DA8511341

KEY WORDS: Fatigue life, Crack propagation, Stochastic processes

The variance of the probability distribution of crack propagation fatigue life is often underpredicted by probabilistic models, especially when the crack growth increment is short. Consequently, the probability of fatigue failure may be underestimated. This dissertation develops a stochastic model in the linear elastic fracture mechanics format which may be used to make better predictions of this distribution.

86-699

Random Load Fatigue: Theory and Experiment

J.M. Tunna

Railway Technical Centre, Derby, England

IMechE, Proc., 199 (C3), pp 249-257 (1985) 10 figs, 4 tables, 10 refs

KEY WORDS: Fatigue life, Random excitation, Design techniques

The problem of fatigue design for random loads is examined. A theory is outlined which allows the fatigue life to be predicted from the constant amplitude stress range-life curve and the standard deviation and ruling frequency of the stress signal. Laboratory tests are described which verify the theory for welded steel constructions in a railway environment.

86-700

Dynamic Fracture Behavior of Structural Materials

J.H. Giovanola, D.A. Shockey

SRI Intl., Menlo Park, CA

Rept. No. AFOSR-TR-85-460, 17 pp (Mar 25, 1985) AD-A154 568/O/GAR

KEY WORDS: Fracture properties

To ensure safe design of Air Force structures, it is necessary to understand the mechanics of high-rate fracture and to have a knowledge of the dynamic fracture properties of component materials. In accord with this need, a research program is being conducted with the goals of developing a test procedure for obtaining reliable dynamic initiation toughness values and establishing the relationship between dynamic initiation and dynamic propagation toughness. This annual report summarizes the progress and results of the fourth research year.

86-701

Approximation of Two Parameter Weibull Distribution by Rayleigh Distributions for Fatigue Testing

L.P. Pook

National Engrg. Lab., East Kilbride, Scotland

Rept. No. NEL-694, 24 pp (1984) PB85-18-2475/GAR

KEY WORDS: Fatigue tests

Predicted lives of engineering structures should be confirmed by fatigue tests on large-scale prototypes under realistic service-loading simulations. Some service loadings approximate to a succession of narrow band random loadings at varying root mean square levels, where the peaks follow the Rayleigh distribution. Often only the long-term distribution of peaks is known. The problem of constructing a sequence of Rayleigh distributions to fit a given long-term distribution of peaks is considered.

WAVE PROPAGATION

86-702

Vibration Analysis of Non-Linear Beams Subjected to a Moving Load Using the Finite Element Method

J. Hino, T. Yoshimura, N. Ananthanarayana

Tokushima University, Tokushima, Japan

J. Sound Vib., 100 (4), pp 477-491 (June 22, 1985) 5 figs, 4 tables, 18 refs

KEY WORDS: Beams, Variable cross section, Nonlinear response, Moving loads, Finite element technique

This paper is concerned with the nonlinear vibration of immovably supported variable beams, in which the geometric nonlinearity due to the axial force generated by stretching the middle surface is taken into account. The results obtained by using these nonlinear models are numerically compared with that obtained by the linear model.

EXPERIMENTATION

MEASUREMENT AND ANALYSIS

86-703

Fisher's Test in Harmonic Analysis

T.K. Basu, F. Roy

Bhabha Atomic Res. Ctr., Bombay, India

Rept. No. BARC-1234, 16 pp (1984) DE859-00982/GAR

KEY WORDS: Harmonic analysis

The role of Fisher's test in harmonic analysis of time series has been discussed. Shimshoni's

(1977) tables have been interpolated and presented for the estimation of the significance of spectral peaks.

86-704
Measurement of Vibrations by Strain Gauges, Part I: Theoretical Basis
G. Pavić
Electrotechnical Institute "Rade Koncar", Yugoslavia
J. Sound Vib., 102 (2), pp 153-163 (Sept 22, 1985) 5 figs, 3 refs

KEY WORDS: Vibration measurement, Strain gages, Plates, Beams

A principle is formulated in which relationships between inertial and elastic properties of structures are utilized for the detection of structural vibrations by means of surface strain measurements. The strain gauge bridges are described, and the bridge sensitivity factors evaluated for measurements of in-plane and flexural vibrations on (arbitrary) plates and beams. Simplified measurement procedures are developed for measurement in far field vibration regions.

86-705
Measurement of Vibrations by Strain Gauges, Part II: Selection of Measurement Parameters
G. Pavić
Electrotechnical Institute "Rade Koncar", Yugoslavia
J. Sound Vib., 102 (2), pp 165-188 (Sept 22, 1985) 16 figs, 3 tables, 4 refs

KEY WORDS: Strain gages, Vibration measurement, Plates, Beams

Theoretical formulations of the methods for measurement of vibrations on plates and beams by strain gages are examined in view of the accompanying measurement errors. Systematic, random and total errors are evaluated in measurements by conventional accelerometers and by proposed strain gauge techniques. Criteria are established for error minimization. An analysis of practical limitations of gauge techniques is carried out, enabling the selection of acceptable measurement parameters to be done. A few experiments are described which confirm a good agreement between the conventional and strain gauge measurement methods.

86-706
Performance Test of a Mechanical Impedance Gauge Based on Strain Measurement on a Rod
K.G. Sundin
Lulea Univ. of Technology, Luleå, Sweden
J. Sound Vib., 102 (2), pp 259-268 (Sept 22, 1985) 6 figs, 3 refs

KEY WORDS: Mechanical impedance, Measuring instruments, Rods

An impedance gauge based on measurement of strains at two cross sections of a slender rod has been tested on practical objects. Sensitive semiconductor strain gauges are used. Therefore, the impact force necessary to excitation is low. Measurements were conducted with the gauge held in contact with the test objects by hand and excited by light strokes from a hammer. With this technique impedances in the transverse direction of beams were measured in the frequency range 20 Hz to 2 kHz. Also, similar measurements were conducted with a conventional impedance head for comparison. The results of the measurements show that the performance of the impedance gauge is good under the prevailing experimental conditions.

86-707
Free Field Measurements of Absorption Coefficients on Square Panels of Absorbing Materials
J.F. Allard, P. Delage
Laboratoire d'Acoustique, Faculté des Sciences du Mans, Route de Laval, 72017 Le Mans Cedex, France
J. Sound Vib., 101 (2), pp 161-170 (July 22, 1985) 5 figs, 3 tables, 11 refs

KEY WORDS: Interferometric techniques, Acoustic measurement, Absorbers (materials), Porous materials, Acoustic absorption

The Kundt interferometer method is not always accurate for absorption coefficient measurements. Free field methods do not have the same limitations but the effect of the sample's finite dimensions has never been studied in detail. A theoretical approach to this topic is presented along with measurements based on the theory.

86-708
Testing Techniques for High Shock Acceleration Sensors (Prüfverfahren für Hochschock-Beschleunigungssensoren)
R.D. Sill

ENDEVCO Deutschland, D-6904 Eppelheim, Fed. Rep. Germany
Techn. Messen-TM, 52 (7/8), pp 299-303 (July/-Aug 1985) 10 figs, 7 refs (In German)

KEY WORDS: Accelerometers, Shock response, Measuring instruments, Hopkinson bar technique, Calibrating

The paper describes testing techniques and equipment used in the development of shock accelerometers having a range beyond 100,000g. A new calibration system based on the Hopkinson bar is presented. Tests to determine sensitivity, amplitude linearity, and zero shift due to accelerations beyond the transducer's designed full scale acceleration level are given. A related apparatus was developed to create submicrosecond rise time strain waves to exite an accelerometer's resonant frequency.

86-709
A Hybrid Method of Modal Synthesis Using Vibration Tests
L. Jezequel
Ecole Centrale de Lyon, Ecully 69130, France
J. Sound Vib., 100 (2), pp 191-210 (May 22, 1985) 5 figs, 6 tables, 34 refs

KEY WORDS: Modal synthesis, Vibration probes

The assembly of structures along continuous boundaries presents great difficulty in the context of modal synthesis. A method is proposed in which a hybrid model is defined reflecting the dynamic behavior of a structure loaded along a boundary. It is based on Weinstein's method and corresponds to a generalization of the impedance matrix method. The hybrid model can be derived from testing as a result of two independent modal identifications. The method permits high precision prediction of the influence of strong structural modifications. Thus, in the case of rectangular plates, it has been possible to find the modes of a cantilever plate and of a plate with stiffeners from the free modes.

86-710
Nonlinear Structural Dynamic Analysis Using a Modified Modal Method
N.F., Jr. Knight
NASA Langley Research Center, Hampton, VA
AIAA J., 23 (10), pp 1594-1601 (Oct 1985) 10 figs, 16 refs

KEY WORDS: Modal methods, Structural members

A procedure for predicting the nonlinear dynamic response of structural components subjected to a step loading is presented. The procedure is a modified modal method that involves a change of dependent variables from the unknown nodal degrees of freedom of the finite element model of the structure to a smaller set of generalized coordinates. This change of dependent variables uses a combination of the nonlinear static solution and some selected vibration mode shapes. The vibration mode shapes correspond to the eigenvectors obtained by solving a standard free vibration eigenvalue problem wherein the stiffness matrix is expanded about the nonlinear static solution. Also strategy is presented for determining which and how many vibration mode shapes to include in the transformation. The effect of inaccurate representation of the spatial distribution of the applied load on the nonlinear dynamic response is discussed for two classes of structural behavior. Application of the procedure to structures that exhibit a stiffening behavior and to those with a softening behavior is presented.

86-711
Frequency Domain Experimental Modal Analysis Techniques
M. Rades
Polytechnic Inst. of Bucharest, Romania
Shock Vib. Dig., 17 (6), pp 3-15 (June 1985) 94 refs

KEY WORDS: Experimental modal analysis, Frequency domain method, Reviews

This paper reviews some recent advances in the development of structural modal identification procedures. Only methods concerned with frequency response data in the frequency domain are considered. Emphasis is on the theoretical background of analytical modal characterization techniques. Testing philosophy is also considered.

DYNAMIC TESTS

86-712
Pseudodynamic Method for Seismic Testing
S.A. Mahin, Pui-Shum B. Shing

Univ. of California, Berkeley, CA
ASCE J. Struc. Engrg., 111 (7), pp 1482-1503 (July 1985) 15 figs, 26 refs

KEY WORDS: Seismic tests, Testing techniques, Computer aided techniques

The pseudodynamic method is a relatively new experimental technique for evaluating the seismic performance of structural models in a laboratory by means of on-line computer controlled testing. During such a test, the displacement response of a structure to a specified dynamic excitation is numerically computed and quasi-statically imposed on the structure. It is based on analytically prescribed inertia and viscous damping characteristics for the structure and the experimentally measured structural restoring forces. This paper presents the basic approach of the method, describing the numerical and experimental techniques. Based on current studies, the capabilities and limitations of the method are examined, and possible improvement methods are mentioned.

86-713
Acoustic Holography: Image Reconstruction. 1975-August 1985 (Citations from the INSPEC: Information Services for the Physics and Engineering Communities Data Base
NTIS, Springfield, VA 229 pp (Aug 1985)PB85-866135/GAR

KEY WORDS: Nondestructive tests, Holographic Techniques, Bibliographies

This bibliography contains citations concerning reconstruction of holographic imagery in nondestructive testing, and deformation detecting and measuring procedures. Applications such as underground detection, weld degradation, steel fractures, and living tissue in the field of medicine are included. Among the systems discussed for achievement of super-resolution of image reconstruction are acoustic, sonic, optical, ultra-sonic, infrared, microwave, seismic, radio, and stereophonic. Online recording, display and storage of acoustic holographic imagery are included.

86-714
Specifying Random Vibration Severity
D.R. Dearth
Applied Analysis & Technology, Huntington Beach, CA
Mach. Des., pp 103, 106 (June 6, 1985) 2 figs

KEY WORDS: Random vibrations, Vibration tests, Testing techniques

A method for specifying random vibration severity for testing purposes from a random vibration spectra relating amplitude to frequency is presented. A typical random vibration spectrum is shown as a log-log graph with the amplitude quantified in terms of acceleration power spectral density, using units of G^2/Hz. A measure of vibration-spectrum severity can be obtained by computing a statistical average called the G_{rms} value, which is the square root of the sum of the total area under a random-vibration spectrum.

86-715
Test Engineers: Advise Production re Stress Screening
W. Tustin
Tustin Inst. of Technology, Santa Barbara, CA
Test, pp 12-15 (Aug/Sept 1985) 5 figs

KEY WORDS: Electronic instrumentation, Screening, Temperature effects, Random vibrations

Stress screening of electronic components using thermal shock in combination with random vibration is described.

86-716
A High Dynamic Engine Test Bench (Hochdynamischer hydraulischer Motorenprufstand)
W. Kern, K. Reyer, K. Schober, G. Weiger
MTZ Motortech Z., 46 (7/8), pp 271-274 (July/Aug 1985) 5 figs (In German)

KEY WORDS: Test facilities, Combustion engines, Dynamometers

A hydraulic dynamometer to be used in test stands for dynamic testing of combustion engines is described.

DIAGNOSTICS

86-717
Elastic Wave Scattering of a Gaussian Incident Beam from an Interface Crack in a Layered Half Space Submerged in Water
S.M. Gracewski

Ph.D. Thesis, Univ. of California, Berkeley, 110 pp (1984) DA8512837

KEY WORDS: Crack detection, Interface: solid-solid, Submerged structures, Elastic waves, Wave scattering

Many industrial products contain parts with thin coatings or layers bonded to thicker substrates. For quality control of these parts, there is need for a nondestructive evaluation (NDE) method to locate and characterize interface flaws and debonding. In this thesis an analytical model for a typical NDE testing configuration is presented.

86-718
Inspection of Railroad Wheels by Impact Generated Rim Waves
M.N. Fahmy
Ph.D. Thesis, Univ. of Houston, 229 pp (1984) DA8512033

KEY WORDS: Crack detection, Railway wheels, Impact hammer tests, Elastic waves, Wave reflection

Surface waves are produced by hammer impact on the rim of a railroad wheel. They travel around the wheel tread, making one complete traverse of the circumference every millisecond. The measurement of the elastic wave reflection from a radial surface crack on the rim cross-section is used to detect its presence and size. The transient signal is measured by an accelerometer then digitized and processed in time frequency and frequency domains. The liftering in the power cepstrum analysis is used to detect the crack echo signal in the main travelling wavelet. The minimum phase sequence of the surface wave signal is obtained by inversion of the windowed complex cepstrum.

BALANCING

86-719
Automatic Balancing of Flexible Rotors, Part I: Theoretical Background
Z. Gosiewski
Technical University of Koszalin, Koszalin, Poland
J. Sound Vib., 100 (4), pp 551-567 (June 22, 1985) 10 figs, 12 refs

KEY WORDS: Balancing techniques, Computer-aided techniques, Flexible rotors, Mode shapes

Some possibilities of automatization of flexible rotors balancing with controlled balancing heads are set out in this paper. A computer is proposed to be the controller. With help of modal analysis of the vibrations generated by unbalance forces a relationship between successive positions of the correction masses is determined. Some calculation procedures for control laws governing the shifting of correction masses in Cartesian or polar co-ordinate systems are introduced.

MONITORING

86-720
Characterization of Acoustic Emission Signals (Executive Summary)
R.K. Miller, H.I. Ringermacher, R.S. Williams, P.E. Zwicke
United Technologies Res. Ctr., East Hartford, CT
Rept. No. FHWA/RD-84/024, 16 pp (Jan 1984) PB85-212488/GAR

KEY WORDS: Monitoring techniques, Acoustic Emission, Bridges

The goals of this program were to develop acoustic emission (AE) techniques. The long term goal is to apply this technology to develop a reliable AE system for monitoring in-service highway bridges to detect and monitor early signs of distress (incipient cracking) in bridge members.

86-721
Computer-Automated Failure Prediction in Mechanical Systems Under Dynamic Loading
C.W. de Silva
Carnegie-Mellon Univ., Pittsburgh, PA
Shock Vib. Dig., 17 (8), pp 3-12 (Aug 1985) 2 figs, 49 refs

KEY WORDS: Monitoring techniques, Computer aided techniques, Reviews

A computer-automated system for failure prediction in mechanical systems having many components that are functionally and physically interconnected is described in this article. This system consists of three subsystem modules:

component failure models developed from available data and procedures; reliability model for the overall mechanical system, developed using functional interrelations and failure models of individual components; and failure diagnostic and model-parameter updating system. The general structures of these three modules and their role in obtaining accurate predictions for time and mode of next failure are discussed. Pertinent background information is provided.

86-722
Condition Monitoring of Helicopter Gearboxes Using Automatic Vibration Analysis Techniques
P. Gadd, P.J. Mitchell
Naval Aircraft Materials Labs., Gosport, UK
Gears and Power Transm. Systems for Helicopters and Turboprops; Conf. Proc., Lisbon, Portugal, Oct 8-12, 1984, AD-A152 673, pp 29-1 - 29-10 AD-P004-673/O/GAR

KEY WORDS: Gear boxes, Helicopters, Monitoring techniques, Signal processing techniques

This paper describes work carried out in the Fleet Air Arm to develop and prove the gearbox vibration techniques involved. Arrangements for data collection in flight and during ground runs are described. The signal processing methods, including the automatic techniques for secondary analysis which enable defined features to be extracted from the basic signatures, are discussed. Examples are given to the extent to which damage or malfunction of various internal components can be discerned by the techniques employed.

86-723
Experimental Investigation of the Applicability and Signal Analysis Methods to Vibration Monitoring of Rolling Element Bearings (Eksperimentel undersøgelse af signalanalytiske metoder til vibrations-overvågning af rulningslejer)
H.W. Thrane, K. Jensen
Ødegaard & Danneskiold-Samsøe K/S, Copenhagen, Denmark
Report #84.114, April 1985 (In Danish-Engl. transl. to be published in 1986)

KEY WORDS: Monitoring techniques, Signal processing techniques, Rolling contact bearings

This report concerns an experimental investigation of vibration signals from rolling element bearings. The bearings have been tested on a test bed which has been developed for the project. Comprehensive analyses have been performed of a number of parameters for monitoring the vibration condition for rotating machinery. Based on the analysis the applicability of the various parameters as indicators of bearing damage was evaluated.

ANALYSIS AND DESIGN

ANALYTICAL METHODS

86-724
Singular Perturbation Analysis of Boundary-Value Problems for Differential-Difference Equations III. Turning Point Problems
C.G. Lange, R.M. Miura
Univ. of California, Los Angeles, CA
SIAM J. Appl. Math., 45 (5), pp 708-734 (Oct 1985) 11 figs, 7 refs

KEY WORDS: Boundary value problems, Perturbation theory

This paper continues a study of a class of boundary-value problems for linear second-order differential-difference equations in which the second-order derivative is multiplied by a small parameter. The problems studied here have solutions which exhibit turning point behavior, i.e., transition regions between rapid oscillations and exponential behavior. The presence of the shift terms can induce large amplitudes and multiphase behavior over parts of the interval. A combination of exact solutions, singular perturbation methods, and numerical computations are used in these studies.

86-725
Singular Perturbation Analysis of Boundary-Value Problems for Differential-Difference Equations II. Rapid Oscillations and Resonances
C.G. Lange, R.M. Miura
Univ. of California, Los Angeles, CA
SIAM J. Appl. Math, 45 (5), pp 687-707 (Oct 1985) 4 figs, 13 refs

KEY WORDS: Boundary value problems, Perturbation theory

This paper continues a study of a class of boundary-value problems for linear second-order differential-difference equations in which the second-order derivative is multiplied by a small parameter. The problems studied have solutions exhibiting rapid oscillations. The presence of the shift terms can induce large amplitudes, multiphase behavior, and resonance phenomena. In particular, two types of resonance phenomena, namely "global" and "local" resonance are studies. A combination of exact solutions, singular perturbation methods, and numerical computations are used in these studies.

86-726
Combining the Methods of Harmonic Balance and Kryloff-Bogoliuboff
C.R. Handy
Atlanta University, Atlanta, Georgia
J. Sound Vib., 102 (2), pp 243-246 (Sept 22, 1985) 1 fig, 3 refs

KEY WORDS: Harmonic balance method, Kryloff-Bogoliuboff method

In a recent work, Mickens has described a set of conditions under which the harmonic balance method (HBM) is implementable. The aim here is to broaden the scope of HBM analysis by drawing attention to the possible combination of such methods with those of Kryloff-Bogoliuboff.

86-727
Harmonic Balance Methods and the Theory of Generalized Padé Approximants
C.R. Handy
Atlanta University, Atlanta, Georgia
J. Sound Vib., 102 (2), pp 247-257 (Sept 22, 1985) 1 table, 5 refs

KEY WORDS: Harmonic balance method

The appropriateness of the theory of generalized Pade approximants is demonstrated for some of the aspects of the harmonic balance method, as discussed in recent work by R.E. Mickens.

86-728
Partial Solution of Large Symmetric Generalized Eigenvalue Problems by Nonlinear Optimization of a Modified Rayleigh Quotient
J.-G. Béliveau, P. Lemieux, Y. Soucy
Université de Sherbrooke, Sherbrooke, Quebec, Canada
Computers Struc., 21 (4), pp 807-813 (1985) 4 tables, 14 refs

KEY WORDS: Eigenvalue problems, Optimization, Rayleigh method

A method is presented to solve numerically the lowest (or highest) eigenvalues and eigenvectors of the symmetric generalized eigenvalue problem. The technique proposed is iterative. It does not transform the original matrices and yields eigencharacteristics in sequence, even for repeated eigenvalues. It is based on a nonlinear optimization of an unconstrained penalty function obtained from a generalization of the Rayleigh quotient. When the normality constraint is imposed, the eigenvectors are obtained by a sequence of solutions to linear equations, all with the same matrix. Examples demonstrate the validity of the method.

86-729
Symbolic Analogies to Solve Vibrational Motions of Such Quasi-Linear Systems without Successive Approximations.
A. Díaz-Jiménez, J.A. Osorio R.
Universidad Francisco José de Caldas, Bogota D.E.
Mech. Res. Comm., 12 (3), pp 119-125 (May/-June 1985) 5 figs, 6 refs

KEY WORDS: Nonlinear systems

In general the exact solution of a nonlinear differential equation cannot be obtained, and only an approximate solution can be obtained. A method is presented which permits to solve nonlinear problems with elementary algebra. It uses i = -1, the Pascal's triangle and canceling the coefficients of the function cosine, after using modeling or symbolic analogies in accordance with synectic.

86-730
Development of a Dynamic Finite Element Model for Unrestrained Flexible Structures
E.R. Christensen
Ph.D. Thesis, Univ. of Maryland, 145 pp (1984) DA8512176

KEY WORDS: Finite element technique, Spacecraft, Elastic restraints, Translational response, Rotational response

An efficient finite element model and solution technique have been developed for the analysis of unrestrained flexible structures. The undergo large elastic deformations coupled with gross nonsteady translational and rotational motions with respect to an inertial reference frame. The nonlinear coupled differential equations resulting from the finite element approximation are integrated timewise. Implicit-explicit split operator numerical integration scheme which treats the stability sensitive terms of the equation implicitly while the rest of the equation is treated explicitly is used. The motion of simple spacecraft structures consisting of flexible beams attached to rigid masses and including the effect of control forces has been studied.

86-731

Plane Elastic Waves in Meshes of Bilinear Finite Elements

Z. Celep
King Saud Univ., Riyadh, Saudi Arabia

J. Sound Vib., 101 (1), pp 23-32 (July 8, 1985) 5 figs, 5 refs

KEY WORDS: Finite element technique, Elastic waves, Wave propagation

Elastic wave propagation in a two-dimensional grid of finite elements having uniform size is investigated. Only bilinear finite elements of rectangular shape are considered. However, the elastic wave is assumed to propagate in an arbitrary direction. Numerical calculations are made to find out the representability of finite elements and the suitability of the lumped masses formulation.

86-732

A Discrete Harmonic Linearization Technique for Simulating Non-Linear Mechanical Systems

S. Rakheja, M. van Vliet, S. Sankar
Concordia University, Montreal, Canada

J. Sound Vib., 100 (4), pp 511-526 (June 22, 1985) 15 figs, 1 table, 18 refs

KEY WORDS: Linearization methods, Vibration isolators

An efficient simulation technique referred to as DH linearization is presented. The non-linear damping mechanisms in vibration isolation systems are represented by an array of viscous damping coefficients which are functions of local values of excitation frequency, and amplitude. The non-linear system is thus represented by a number of algebraic expressions.

86-733

A Contribution on Forced Periodic Oscillations with Piecewise Linear and Constant Damping

D. Karius
MTG Marinetechnik GmbH, Hamburg, Federal Republic of Germany

J. Vib., Acoust., Stress Rel. Des., Trans. ASME 107 (4), pp 383-391 (Oct 1985) 24 figs, 12 refs

KEY WORDS: Periodic response, Coulomb friction

In control system design and precision mechanics it is important to know the precise motion of excited or self-excited vibration under the influence of dry friction. In this paper, the motion of such a nonlinear oscillator is analyzed with the aid of *pointmappings*. As an example, a nonlinear function of damping dependent on the velocity can be approximated by piecewise linear functions.

86-734

Dynamics of a System Exhibiting the Global Bifurcation of a Limit Cycle at Infinity

W.L. Keith, R.H. Rand
Cornell University, Ithaca, NY

Intl. J. Nonlin. Mech., 23 (4), pp 325-338 (1985) 15 figs, 12 refs

KEY WORDS: Limit cycle analysis, Bifurcation theory

The non-linear term contains two parameters which may be varied to give the Rayleigh and Van der Pol differential equations as special cases. The existence and approximation of limit cycles in this system are investigated. The Poincare-Bendixson theorem and the Lindstedt perturbation method are used. Numerical integration is used to verify the analytical results. It is shown that an arbitrarily small perturbation to the damping term of the Rayleigh equation results in points close to the stable limit cycle escaping to infinity.

86-735

An Improved Approach for Random Parametric Response of Dynamic Systems with Non-Linear Inertia

R.A. Ibrahim, A. Soundararajan
Texas Tech Univ., Lubbock, TX
Intl. J. Nonlin. Mech., 23 (4), pp 309-323 (1985)
8 figs, 20 refs

KEY WORDS: Random parameters, Parametric response, Inertial forces

A non-Gaussian closure scheme is developed for determining the stationary response of dynamic systems including non-linear inertia and stochastic coefficients. Numerical solutions are obtained and examined for their validity based on the preservation of moments properties. The method predicts the jump phenomenon, for all response statistics at an excitation level very close to the threshold level of the condition of almost sure stability. In view of the increased degree of non-linearity, resulting from the non-Gaussian closure scheme, the mean square of the response displacement is found to be less than those values predicted by other methods such as the Gaussian closure or the first order stochastic averaging.

86-736
Anharmonic Oscillators Revisited
J.P. Codaccioni, R. Caboz
Université de Pau, Pau, France
Intl. J. Nonlin. Mech., 23 (4), pp 291-295 (1985)
1 fig, 15 refs

KEY WORDS: Hamiltonian functions, Equations of motion

A large class of anharmonic oscillators represented by a Hamiltonian is considered. Owing to an integration technique using the Lagrange-Burmann theorem the solution of the motion equation is given in terms of series of Gauss hypergeometric functions. The period and the action integral of bounded motions are finally expressed in terms of energy in the form of generalized hypergeometric functions.

NONLINEAR ANALYSIS

86-737
Vibrational Control of Nonlinear Systems
J. Bentsman
Ph.D. Thesis, Illinois Inst. of Technology, 87 pp (1984) DA8510286

KEY WORDS: Nonlinear systems, Vibration control

The purpose of the thesis is to establish the basis of vibrational control theory for nonlinear systems. The notions of vibrational stabilizability and vibrational controllability of nonlinear finite-dimensional systems are introduced and analyzed. Calculation formulae are derived. Transient behavior of vibrationally controlled nonlinear systems is studied. Several examples, including forced Duffing, Rayleigh and Van der Pol equations as well as chemical reactions and genetic model, are discussed. Vibrational control is shown to be a viable alternative in nonlinear systems control.

NUMERICAL METHODS

86-738
The Effect of Support Vibration on the Dynamic Stability and Periodic Vibrations of Plane Mechanisms (Über Den Einfluss Von Schwingungen Des Gestells Auf Die Dynamischen Stabilitätsbedingungen und Periodischen Schwingungen Ebener Mechanismen
Nguyen Van Khang
Polytechnische Hochschule Hanoi, Hanoi, Vietnam
Rev. Roumaine Sci. Tech., Mecanique Appl., 29 (3), pp 255-261 (1984) 3 figs, 2 tables, 8 refs (In German)

KEY WORDS: Numerical methods

A numerical method for the determination of the effect of support vibration on the dynamic stability parameters and on periodic vibration of plane mechanisms is given. A numerical example is also included.

PARAMETER IDENTIFICATION

86-739
Modelling and Parameter Estimation for Distributed Vibratory Systems
D.L. Russell
Wisconsin Univ., Madison, WI
Rept. No. AFOSR-TR-85-444, 43 pp (Mar 1985)
AD-A154 518/5/GAR

KEY WORDS: Parameter identification technique, Continuous parameter method

The investigators make some general comments concerning mathematical models which appear to be appropriate for modeling certain vibratory systems of distributed parameter type. Aspects discussed include: location of vibrational spectra, damping rates, and spectral displacement due to mass density and/or elasticity variations. Particular emphasis is placed on some properties of segmented beams. The article ends with a preliminary mathematical discussion of the feasibility of parameter identification, from vibrational spectrum data alone, in the wave and Euler-Bernoulli beam equations.

86-740
The Effects of Structural Error on Parameter Identifiability of Dynamical Systems
Y. Hadaegh
Ph.D. Thesis, Univ. of Southern California (1984)

KEY WORDS: Parameter identification technique

This study presents a reformulation of the identifiability problem on the basis of equivalence and near-equivalence between a model and the process it represents.

COMPUTER PROGRAMS

86-741
Finite Element Analysis of Static and Dynamic Structural Engineering Problems Using Semi-Explicit Methods
R. Purasinghe
Ph.D. Thesis, Case Western Univ., 116 pp (1985)
DA8510102

KEY WORDS: Computer programs, Finite element technique

Improved semi-explicit methods to solve static and dynamic structural engineering problems are presented. They have computer implementation advantages in large and small systems. In solving structural dynamic problems in large systems an unsymmetric splitting method of the stiffness matrix is presented. This technique has the advantage of an explicit method that no matrix factorization of the effective stiffness matrix is necessary at each time step. Besides this method has the advantage of an implicit method that a large time step, larger than that provided in a classical explicit formulation is achieved.

86-742
Automated Analysis of Constrained Systems of Rigid and Flexible Bodies
A.A. Shabana
Univ. of Illinois at Chicago, Chicago, IL
J. Vib., Acoust., Stress Rel. Des., Trans. ASME, 107 (4), pp 431-439 (Oct 1985) 15 figs, 11 refs

KEY WORDS: Constrained structures, Mathematical models, Computer programs

This paper is concerned with modeling inertia properties of flexible components that undergo large angular rotations. Consistent, lumped and hybrid mass techniques are presented in detail and used to model the inertia properties of flexible bodies. The consistent formulation allows using the finite-element method as well as Rayleigh-Ritz method to describe the deformation of elastic components. Lumped mass techniques allow using shape vectors or experimentally identified data. In the hybrid mass formulation, the flexibility mass matrix is evaluated using a consistent mass formulation. The inertia coupling between gross rigid body motion and elastic deformation is formulated using a lumped mass technique. Different mass formulations require the evaluation of similar sets of time-invariant matrices that represent the inertia coupling.

AUTHOR INDEX

ABSTRACT CATEGORIES

MECHANICAL SYSTEMS

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APRIL

8-11 International Conference on Acoustics, Speech, and Signal Processing [Acoustical Society of Japan, IEEE ASSP Society, and Institute of Electronics and Communication Engineers of Japan] Tokyo, Japan (Hiroya Fujisaki, EE Department, Faculty of Engineering, University of Tokyo, Bunkyo-ku, Tokyo 113, Japan)

13-16 American Power Conference [ASME] Chicago, IL (ASME)

29-1 9th International Symposium on Ballistics [Royal Armament Research and Development Establishment] RMCS, Shrivenham, Wiltshire, UK (Mr. N. Griffiths, OBE, Head/XT Group, RARDE, Fort Halstead, Sevenoaks, Kent TN14 7BP, England)

MAY

5-9 32nd Annual Technical Meeting of the Institute of Environmental Sciences [IES] Dallas/Ft. Worth Airport, TX (IES, 940 E. Northwest Highway, Mt. Prospect, IL 60056 - (312) 255-1561)

12-16 Acoustical Society of America, Spring Meeting [ASA] Cleveland, OH (ASA Hqs.)

JUNE

3-6 Symposium and Exhibit on Noise Control [Hungarian Optical, Acoustical, and Cinematographic Society; National Environmental Protection Authority of Hungary] Szeged, Hungary (Mrs. Ildiko Baba, OPAKFI, Anker koz 1, 1061 Budapest, Hungary)

8-12 Symposium on Dynamic Behavior of Composite Materials, Components and Structures [Society for Experimental Mechanics] New Orleans, LA (R.F. Gibson, Mech. Engrg. Dept., University of Idaho, Moscow, ID 83843 - (208) 885-7432)

24-26 Machinery Vibration Monitoring and Analysis Meeting [Vibration Institute] Las Vegas, NV (Dr. Ronald L. Eshleman, Director, The Vibration Institute, 101 W. 55th St., Suite 206, Clarendon Hills, IL 60514 - (312) 654-2254)

JULY

20-24 International Computers in Engineering Conference and Exhibition [ASME] Chicago, IL (ASME)

21-23 INTER-NOISE 86 [Institute of Noise Control Engineering] Cambridge, MA (Professor Richard H. Lyon, Chairman, INTER-NOISE 86, INTER-NOISE 86 Secretariat, MIT Special Events Office, Room 7-111, Cambridge, MA 02139)

24-31 12th International Congress on Acoustics, Toronto, Canada (12th ICA Secretariat, P.O. Box 123, Station Q, Toronto, Ontario, Canada M4T 2L7)

SEPTEMBER

14-17 International Conference on Rotordynamics [IFToMM and Japan Society of Mechanical Engineers] Tokyo, Japan (Japan Society of Mechanical Engineers, Sanshin Hokusei Bldg., 4-9, Yoyogi 2-chome, Shibuyak-ku, Tokyo, Japan)

22-25 World Congress on Computational Mechanics [International Association of Computational Mechanics] Austin, Texas (WCCM/TICOM, The University of Texas at Austin, Austin, TX 78712)

29-30 VDI Vibrations Meeting [Society of German Engineers] Wurzburg, Fed. Rep. Germany (Society of German Engineers)

OCTOBER

5-8 Design Automation Conference [ASME] Columbus, OH (ASME)

5-8 Mechanisms Conference [ASME] Columbus, OH (ASME)

7-9 2nd International Symposium on Shipboard Acoustics ISSA '86 [Institute of Applied Physics TNO] The Hague, The Netherlands (J. Buiten, Institute of Applied Physics TNO, P.O. Box 155, 2600 AD Delft, The Netherlands, Telephone: xx31 15787053, Telex: 38091 tpddt nl)

14-16 57th Shock and Vibration Symposium [Shock and Vibration Information Center] New Orleans, LA (Dr. J. Gordan Showalter, Acting Director, SVIC, Naval Research Lab., Code 5804, Washington, D.C. 20375-5000 - (202) 767-2220)

19-23 Power Generation Conference [ASME] Portland, OR (ASME)

20-22 Lubrication Conference [ASME] Pittsburgh, PA (ASME)

NOVEMBER

3-6 14th Space Simulation Conference [IES, AIAA, ASTM, NASA] Baltimore, MD (Institute of Environmental Sciences, 940 E. Northwest Highway, Mt. Prospect, IL 60056 - (312) 255-1561)

30-5 American Society of Mechanical Engineers, Winter Annual Meeting [ASME] San Francisco, CA (ASME)

CALENDAR ACRONYM DEFINITIONS AND ADDRESSES OF SOCIETY HEADQUARTERS

AHS American Helicopter Society
1325 18 St. N.W.
Washington, D.C. 20036

AIAA American Institute of Aeronautics and Astronautics
1633 Broadway
New York, NY 10019

ASA Acoustical Society of America
335 E. 45th St.
New York, NY 10017

ASCE American Society of Civil Engineers
United Engineering Center
345 E. 47th St.
New York, NY 10017

ASLE American Society of Lubrication Engineers
838 Busse Highway
Park Ridge, IL 60068

ASME American Society of Mechanical Engineers
United Engineering Center
345 E. 47th St.
New York, NY 10017

ASTM American Society for Testing and Materials
1916 Race St.
Philadelphia, PA 19103

ICF International Congress on Fracture
Tohoku University
Sendai, Japan

IEEE Institute of Electrical and Electronics Engineers
United Engineering Center
345 E. 47th St.
New York, NY 10017

IES Institute of Environmental Sciences
940 E. Northwest Highway
Mt. Prospect, IL 60056

IMechE Institution of Mechanical Engineers
1 Birdcage Walk, Westminster
London SW1, UK

IFToMM International Federation for Theory of Machines and Mechanisms
U.S. Council for TMM
c/o Univ. Mass., Dept. ME
Amherst, MA 01002

INCE Institute of Noise Control Engineering
P.O. Box 3206, Arlington Branch
Poughkeepsie, NY 12603

ISA Instrument Society of America
67 Alexander Dr.
Research Triangle Pk., NC 27709

SAE Society of Automotive Engineers
400 Commonwealth Dr.
Warrendale, PA 15096

SEE Society of Environmental Engineers
Owles Hall, Buntingford, Hertz.
SG9 9PL, England

SESA Society for Experimental Mechanics (formerly Society for Experimental Stress Analysis)
14 Fairfield Dr.
Brookfield Center, CT 06805

SNAME Society of Naval Architects and Marine Engineers
74 Trinity Pl.
New York, NY 10006

SPE Society of Petroleum Engineers
6200 N. Central Expressway
Dallas, TX 75206

SVIC Shock and Vibration Information Center
Naval Research Laboratory
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Unsolicited articles are accepted for publication in the **Shock and Vibration Digest.** Feature articles should be tutorials and/or reviews of areas of interest to shock and vibration engineers. Literature review articles should provide a subjective critique/summary of papers, patents, proceedings, and reports of a pertinent topic in the shock and vibration field. A literature review should stress important recent technology. Only pertinent literature should be cited. Illustrations are encouraged. Detailed mathematical derivations are discouraged; rather, simple formulas representing results should be used. When complex formulas cannot be avoided, a functional form should be used so that readers will understand the interaction between parameters and variables.

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Manuscripts must begin with a brief abstract, or summary. Only material referred to in the text should be included in the list of References at the end of the article. References should be cited in text by consecutive numbers in brackets, as in the following example:

> Unfortunately, such information is often unreliable, particularly statistical data pertinent to a reliability assessment, as has been previously noted [1].
>
> Critical and certain related excitations were first applied to the problem of assessing system reliability almost a decade ago [2]. Since then, the variations that have been developed and practical applications that have been explored [3-7] indicate . . .

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- abbreviated title of journal in which article was published (see Periodicals Scanned list in January, June, and December issues)
- volume, issue number, and pages for journals; publisher for books
- year of publication in parentheses

A sample reference list is given below.

1. Platzer, M.F., "Transonic Blade Flutter -- A Survey," Shock Vib. Dig., 7 (7), pp 97-106 (July 1975).
2. Bisplinghoff, R.L., Ashley, H., and Halfman, R.L., Aeroelasticity, Addison-Wesley (1955).
3. Jones, W.P., (Ed.), "Manual on Aeroelasticity," Part II, Aerodynamic Aspects, Advisory Group Aeronaut. Res. Dev. (1962).

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Volume 18, No. 3 **March, 1986**

EDITORIAL

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